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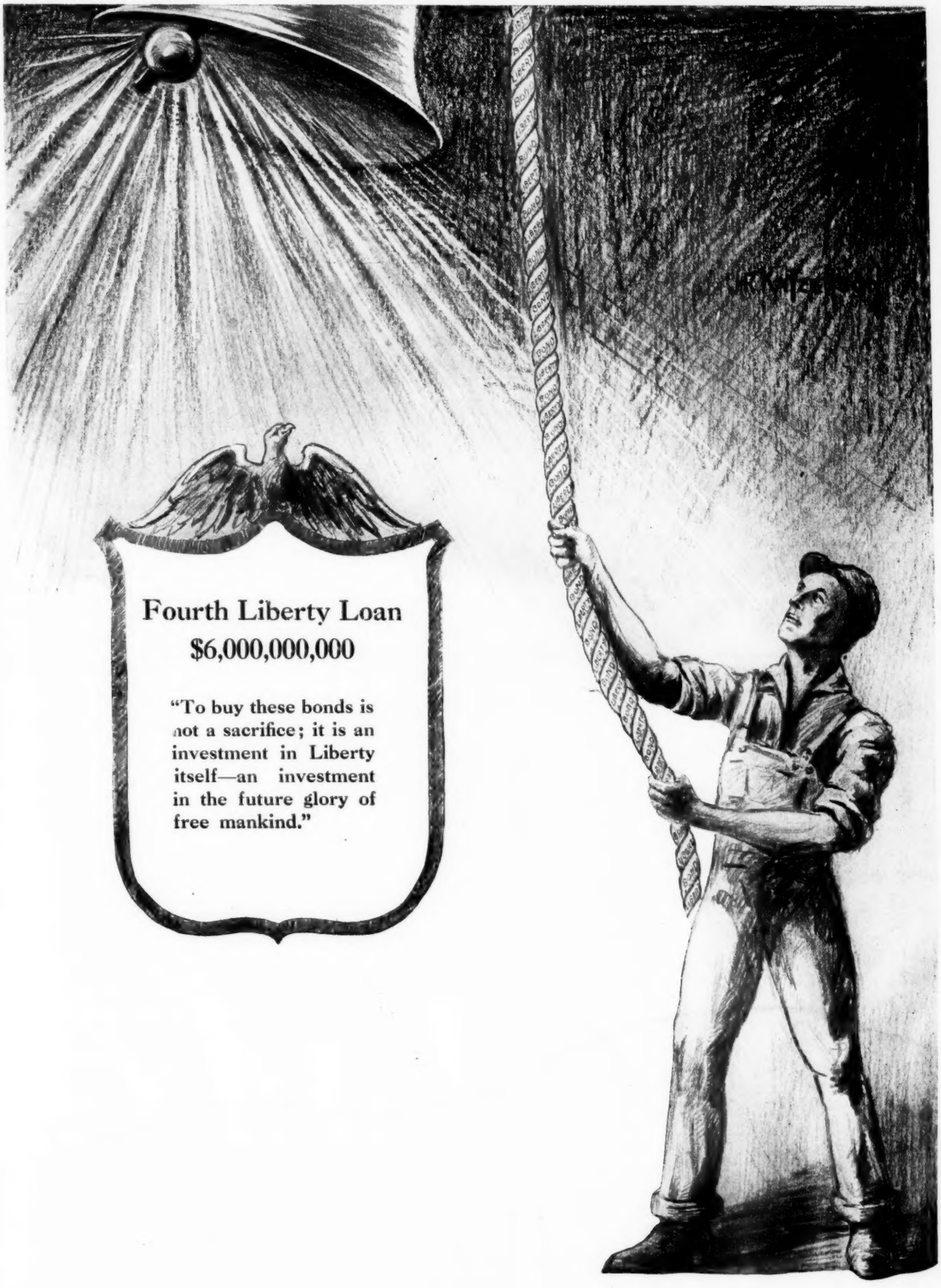
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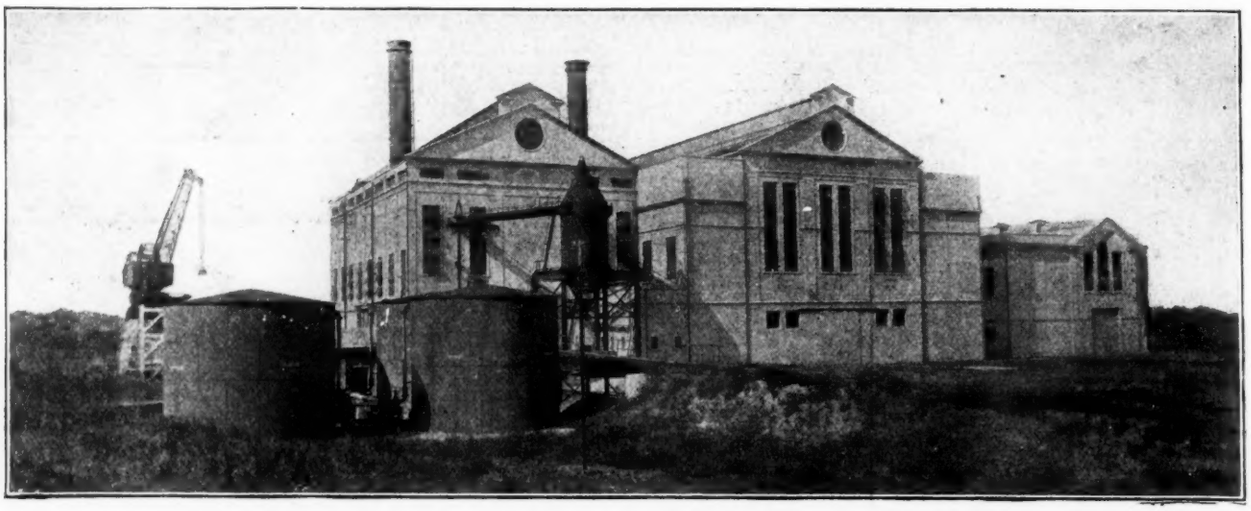


FIG. 1. MAIN BUILDINGS, OFFICE AND POWER PLANT OF THE CENTRAL ARGENTINE RAILWAY

Electrification of the Central Argentine Railway

The Central Argentine Railway, with 3300 miles of track, serves the area between Tucuman, Cordoba and Rio Quarto on the west and Santa Fé, Rosario and Buenos Aires on the River Plata. That portion of the system from Retiro Terminus in Buenos Aires to Tigre on the Las Conchas River via Victoria, was electrified during the month of August, 1916, and thus has the distinction of being the first great railway line in Argentina to adopt this method of dealing with suburban traffic.

THE entire plant and equipment for electrically operating a portion of the Central Argentine Railway was manufactured in Great Britain. The principal contractors for the erection of the plant were: Power station buildings and complete boiler-house equipment, Babcock & Wilcox, Ltd.; turbo-alternators, transformers and motors, C. A. Parsons & Co., Ltd.; condensing plant and pumps, British Westinghouse Electric and Manufacturing Co., Ltd.; switch gear in power station, auxiliary motors, etc., British Thomson-Houston Co., Ltd.; high-tension transmission and low-tension track cables, W. T. Henley's Telegraph Works, Ltd.; structural steelwork for power-station entranceway, testroom, offices and substations, also the cranes for the substations, David Rowell & Co., Ltd.; Electrical equipment of substations, British Thomson-Houston Co., Ltd.; rolling stock, bodies, under-frames and bogies, Metropolitan Carriage, Wagon and Finance Co., Ltd., Birmingham Carriage and Wagon Co., Ltd.; rolling stock, electrical equipment, British Thomson-Houston Co., Ltd.; supervision of erection of electrical equipment of permanent way, British Thomson-Houston Co., Ltd.

The power house is situated between the Tigre (Rosario) line and the Rio Lujan. The site was swampy, and in order to get a sound foundation about 3000 ferro-concrete piles were driven to hard clay about 33 ft. below the surface. On top of these piles a concrete raft 2½ ft. thick, reinforced with old rails, was laid. The offices, laboratory and rotary converters are housed in the building or portion of the three connected buildings shown at the extreme right. The engine room is next in order, and parallel with it, to the left, is the boiler house. The coal-storage yard adjoins the boiler house in the rear and is equipped with a long-reach grab-bucket swing crane for unloading coal from the cars, discharging it directly to the boiler-room conveyors or to the storage yard. At the end of the engine room are the fitting or repair shop and the workmen's dressing rooms. All the buildings are steel-framed, paneled with armored concrete finished with white cement. The roof of the office and converter building is of concrete. That of the engine house consists of a wood ceiling covered with waterproof felt and corrugated iron on top; this construction was required to avoid the condensation of moisture from hot, humid air striking a cold corrugated iron roof. The boiler house is roofed with corrugated iron without the underlying sheathing. Table I gives particulars of the principal boiler-house equipment.

TABLE 1—DETAILS OF BOILER-HOUSE PLANT

Number and type of boilers	6 Babcock & Wilcox marine-type water-tube
Normal evaporation of each boiler	20,000 lb. of water per hour
Working steam pressure and temperature	210 lb. per square inch; 600° F.
Heating surface of each boiler	4,170 sq.ft.
Grate area of each boiler	98 sq.ft.
Type of stokers	Underfeed
Type and size of economizers	Green's; 200 pipes in each
Number of fans	8 Sirocco fans
Number and type of feed pumps	2 impulse-turbine-driven centrifugal pumps, 2 vertical reciprocating, Nichols type; capacity of each feed pump, 375,000 lb. per hour

The boilers are arranged four on a side, grouped in pairs, each boiler having its own superheater and economizer. One steel chimney with an induced-draft fan serves each pair of boilers, and forced draft is supplied to the furnaces by four fans in the basement. In anticipation of a shortage of coal two of the boilers were arranged for oil firing and a complete equipment of the Wallsend-Howden system has been put into operation, with storage tanks, filters and pumps. As the shortage of both coal and oil, due to war conditions, became more acute, other boilers were adapted for wood firing and

the fuel-consumption figures for a recent week are: Coal, 72.5 tons; oil, 15.5 tons; wood, 690 tons. The wood burned is red and white quebracho and algarroba, and the relative values of the different fuels are roughly as follows: 1 lb. of coal (calorific value 15,000 B.t.u.) is equivalent to 0.8 lb. of oil, 2.5 lb. of red quebracho, 3.3 lb. of white quebracho, 3.3 lb. of algarroba. The combined efficiency of the boilers and economizers is about 85 per cent. when Welsh coal is being burned.

The feed pumps draw their supply from hotwell tanks in the pumphouse, and makeup water comes from a storage reservoir constructed alongside the power station to two storage tanks erected above the hotwells. Water is pumped from the River Lujan through a 6-in. pipe to the reservoir and is there treated with aluminoferric to precipitate the sediment which the river water contains.

The steam piping consists of a range of solid drawn pipes, the flanges, of forged steel, being riveted in the case of pipes of 7 in. diameter and over, and screwed in the case of smaller pipes. The blowoff piping connecting to a blowoff sump is solid drawn steel. The exhaust and escape steam piping is lap-welded.

Coal and Ash Handling Plant

Storage and handling coal are provided for by means of an elevated railway track running alongside the boiler house at firing-floor level, a gantry parallel to the buildings carry a level-luffing jib crane with a grab bucket of two tons capacity, and two sidings at ground level. The coal cars are brought from the main line and the coal can be grabbed from them and either filled directly into two 15-ton receiving hoppers, or into bottom discharge cars which can be hauled along the elevated siding by a winch till they come over the receiving hoppers; thence the coal passes through crushers and by gravity to bucket conveyors. These elevate it to a tray conveyor which takes it to coal bunkers above and between the two ranges of boilers. The coal bunkers, having a capacity of 1000 tons, are built of mild-steel plates lined with armored cement and the bottoms are V-shaped in section. Alternatively, the arriving cars can be pushed up the incline to the elevated siding and the fuel—coal or wood—can be discharged directly on the firing floor by hand. The stock coal is grabbed from the cars and stored below and around the gantry in a floored coal deposit constructed within range of the jib crane, which can plumb a radius of 50 ft. The capacity of this storage is 10,000 tons. The ash-handling arrangements comprise a suction ash plant with two 28-hp. exhausters which take the ashes from the furnace ashpits through electrically operated crushers and specially heavy cast-iron pipes to a mild-steel ash bunker of 80 tons capacity lined internally with armored concrete. The bunker is erected at the end of the boiler house at such a height that railway cars can pass underneath to receive and remove the ashes. Alternatively, the ashes can be taken from the ashpits by half-ton cars along rail tracks, laid along each side of the boiler-house basement and deposited outside on the site.

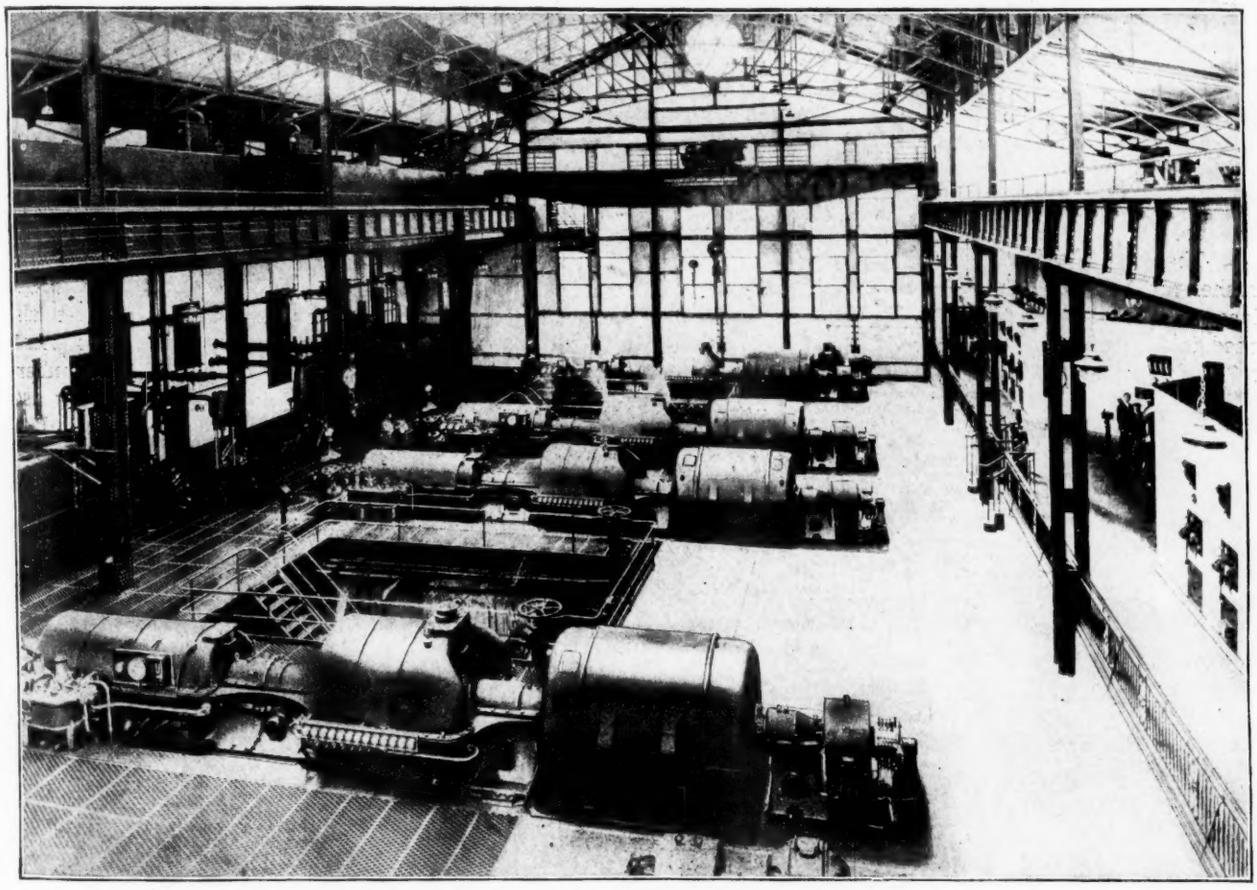


FIG. 2. INTERIOR VIEW OF ENGINE ROOM WITH CONTROL PANELS UNDER THE BALCONY AT THE RIGHT

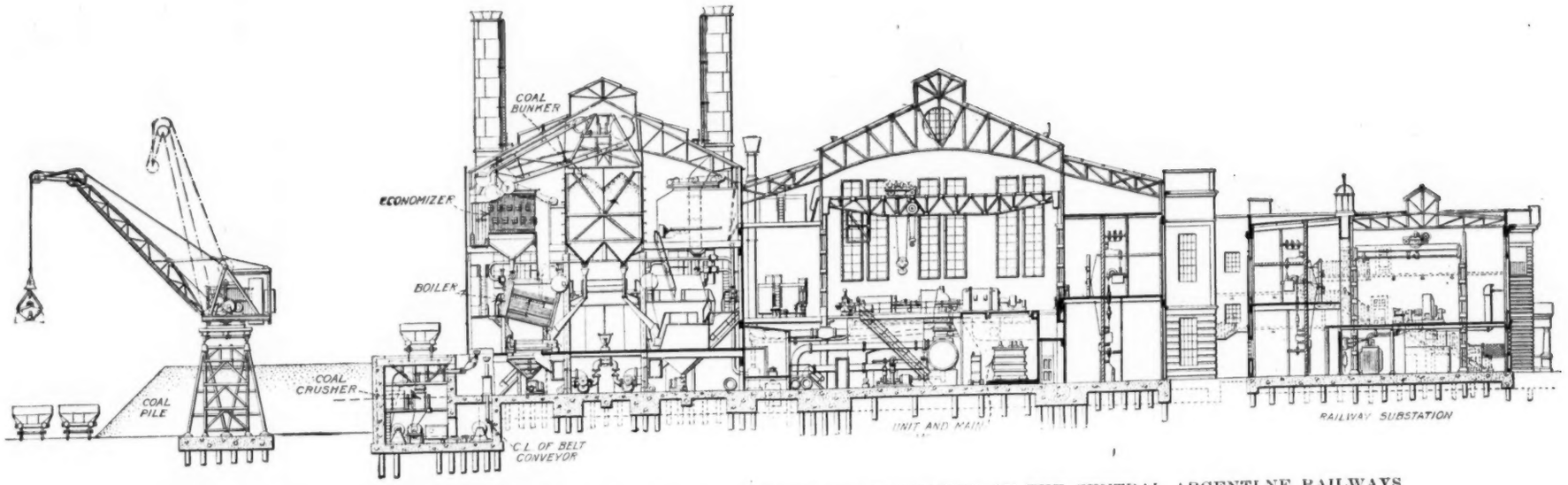


FIG. 3. SECTIONAL VIEW OF THE POWER PLANT AND COAL-HANDLING EQUIPMENT OF THE CENTRAL ARGENTINE RAILWAYS

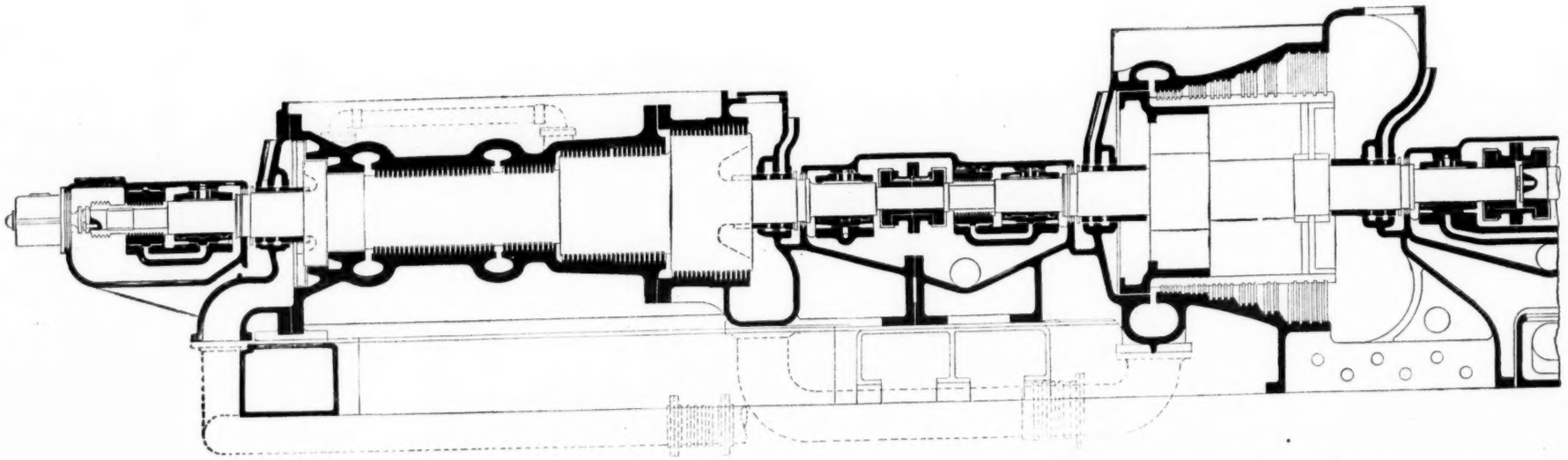


FIG. 4. CROSS-SECTION OF COMPOUND TURBINE UNIT: UP TO THE GENERATOR COUPLING, SHOWN AT LENGTH IN FIG. 5

The steam supply to the generating plant is so arranged that any one of the boilers can supply any one of the turbines, giving a supply of current to the main busbars and all the station auxiliaries. In addition, the breakdown of anything comprised in one generating unit will not prevent the operation of the remaining sets. There are four turbines in the engine room. Each has its own steam-driven oil pump for use when starting up, its own condenser with air and water extraction pumps, and an independent circulating water pump. On the electrical side it has a self-excited exciter direct-coupled to the alternator shaft. Leads from the alternator run directly to the "unit" transformer, which steps down the generated voltage from 2500 to 440 and gives a supply to the unit distribution board. From this board are fed the motors that operate the auxiliaries definitely belonging to the generating set to which it is attached; namely, those driving the air pump, exhaust valve, step-up transformer, oil pump and circulating-water pump. The other station auxiliaries, economizer and fan motors, common to the whole station, are fed from a station distribution board divided into four sections, each of which can be isolated at will and fed from one of the unit boards, the feeders to the auxiliaries being so distributed among the sections that failure of one section will not put out of operation all

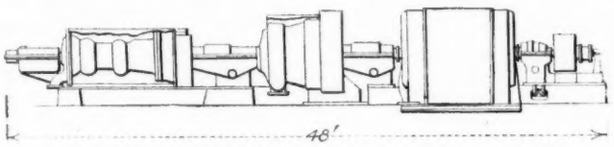


FIG. 5. GENERAL OUTLINE OF COMPLETE UNIT

the individual pieces of any auxiliary gear. The main leads from the alternator (1 sq.in. single-core cable) run to a step-up transformer, housed in the same compartment as the unit transformer, which steps up the generated voltage from 2500 to 20,000, at which tension the power is supplied to the station busbars. The station equipment as a whole is divided into two independent parts either one capable of running without the other. The main busbars are divided in the middle by a busbar sectioning switch; two generators feed each half, and from each half a supply is given to a "station" transformer. Either of these station transformers can feed the station distribution board, the four sections of which are normally run coupled up. Connected to the extreme sections of the station distribution board are two motor-generators giving a supply for lighting the station and for charging the two storage batteries which form a duplicate source of power for the tripping coils on the switches and the indicating lamps on the switchboard. The main outgoing feeders are distributed between the busbar sections so that failure of one section will not shut down any substation.

The high- and low-pressure portions of the turbines are in separate cylinders, the high-pressure cylinder being of cast steel. This was steamed with superheated steam for 24 hours both before and after blading. The rotor shafts and drums are forged of solid steel with a tensile strength of 35 to 40 tons and an elongation of 20 per cent. The blades are brass. Each turbine is connected by an expansion pipe to the condenser situated underneath it. Between the turbine and the hand- or electrically operated main exhaust valve is an atmospheric relief valve. The governor is mechanical and automatic in action and so constructed that the speed between no load and maximum load can be varied 5 per cent. up or down while the turbine is running. The speed can also be controlled by hand or from the switchboard by electrical means. Oil is supplied continuously under pressure to the bearings, whence it passes through strainers to the oil reservoir, to be picked up by an oil pump and forced through the tubes of an oil cooler. Fig. 4 is a sectional view of the turbine.

The alternators are fully inclosed and ventilated by fans, on the rotor, which draw air from the basement through a dry-air filter and discharge it outside the engine room. The combination of an alternator and a step-up transformer as one generating unit permitted the actual alternator voltage to be selected so as to give the most simple and robust stator winding. The stator slots are completely closed; each contains only one conductor. The rotors are of the built-up plate construction with a distributed winding in slots and are fitted with mild-steel slip-rings.

The step-up and unit transformers belonging to each generating set are housed in a separate chamber in the basement with hatchways in the engine-room floor through which they can be handled by the crane. The chambers are ventilated by fans which draw air from the basement and provision is made for running off the oil from the transformers to the outside of the building in case of fire. Each step-up transformer has its own oil-cooler through which the oil is circulated by a rotary pump driven by a 10-hp. 440-volt three-phase squirrel-cage motor. The unit transformers are air-cooled. The station transformers are situated in separate chambers at the ends of the engine-room basement and are air-cooled.

An oil storage was built on the power-station site to contain the supplies of transformer and lubricating oil. An electrically operated oil-purifying outfit is used for filtering and drying the transformer oil after it has been in service for some months.

The Condensing Plant

The condensing water is taken from a pumphouse on the River Lujan through two 27-in. pipes about 1500 ft. long and is discharged into a small creek somewhat nearer the power station, called the Rio Rosquetes. The condenser shells are cast iron and the tube plates are rolled brass 1½ in. thick. The tubes are ¾ in. external diameter and are of solid drawn copper of No. 18 s.w.g. Aluminum blocks are fixed in the water chambers in metallic contact with the tube plates. The air and water extraction pumps together with their driving motor are mounted on one bedplate. The circulating-water pump bodies are of cast iron and the impellers are of gun metal. The circulating-water pump motors are housed in a steel-framed, corrugated sheet iron house erected on a wooden jetty projecting from the bank of the river. The site of the jetty was dredged before the wooden jetty piles were driven, and each pump is mounted in a tank so that its center line is approximately at high-water level. The suction pipe is carried to such a depth as to insure being submerged in all

stages of the river. One side of the jetty consists of two screens of expanded metal arranged so that one screen at a time can be raised for cleaning. Flexible couplings are provided between the motors and the pumps to allow for settlement and straining of the jetty.

In addition to the main circulating-pump motors the jetty carries a centrifugal pump capable of delivering 300 gal. per min. against a head of either 20 or 95 ft. This supplies water through a 6-in. pipe either to the purified-water reservoir or direct to the storage tanks in the pumphouse. Two motor-driven air exhausters, for priming the pumps, are also located in the pumphouse, each capable of producing, in three minutes, a vacuum of 20 in. in any one of the main pumps, including its suction pipe and discharge pipe up to the discharge valve.

The main pump motors are started by means of oil-immersed auto-starters consisting of two separate single-phase transformers and the starting switch. Each motor is connected by a separate cable to one of the unit distribution boards in the power house.

Owing to the swampy nature of the ground between the river and the station it was not possible to lay the circulating-water pipes directly in a trench. Instead they were erected on cross-bearers carried by pairs of wooden piles driven down to the tosca. The cables are carried on angle irons supporting from the cross-timbers Where the inlet pipes cross the Rio Rosquetes, they are carried on a steel girder bridge. The pipes, which are steel, are wrapped with tarred Hessian tape.

Operation of Forced-Draft Equipment

By J. F. Tutein

Many of the large stokers purchased today are of the underfeed, forced-draft type, which have many advantages over those operated by natural draft; namely, increased capacity, lower maintenance and labor expense, and in plants having heavy peak loads at certain parts of the day, better twenty-four hour efficiency, due to the reduction of banked-fire hours during the light-load periods.

Many heavily loaded natural-draft plants have changed over to this type of stoker, with these facts in view; but on account of the difficulty in getting a man who thoroughly understands and can operate a forced-draft equipment properly, they have failed in many cases to obtain the expected results. One of the greatest mistakes that an inexperienced operator makes is in carrying an excessive pressure under the fire to increase the capacity, which causes trouble and expense.

Three of the most essential points that should be considered in getting capacity from this kind of equipment are: First, that the stoker should be able to feed the required amount of coal; second, that the fans should furnish sufficient air to burn the coal, and third, that the stack should be large enough to carry away the products of combustion. As a rule the first two points are well covered and the limit of capacity is determined by the capacity of the stack alone. Therefore it is evident that with the stack damper wide open and a balanced draft in the furnace, any further increase in air pressure under the fire is useless, as the gas, not being able to get out the stack, creates a pressure in the furnace and forces its way out around the doors and dump grates, burning them and destroying the brickwork.

The gas escaping this way does not pass through the boiler and consequently does not increase the output; there is, however, some gain in capacity, as the pressure in the furnace forces part of the extra heat through the boiler and out the stack, although this small gain is heavily paid for in coal and cost of repairs.

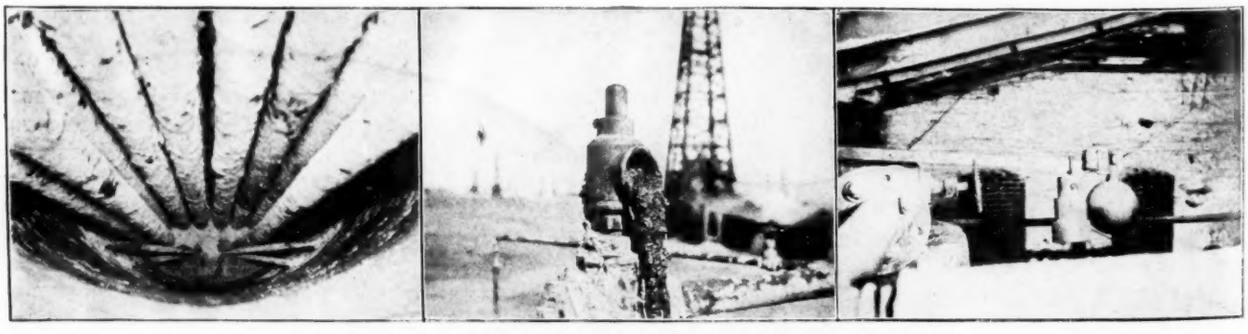
Strange to say, many forced-draft outfits have been sold, to replace natural-draft furnaces, with a guarantee of 250 per cent. of rating for four hours, without the size of the stack being taken into consideration at all. Then when the stoker company's operator runs the acceptance test, he carries a high blast pressure, forces through the boiler gas that the stack was never designed to carry away and obtains the required output.

At this time, when the installation is new, with tight door-frames and brickwork, he is better able to accomplish this result; but when the permanent operator has tried to duplicate this performance a few times, and the brickwork has become cracked, and the door-frames warped, on account of it, a large amount of gas and flame escapes around the setting, showing up the defects of faulty operation.

In a case of this kind the installation of a draft gage with strict instructions to carry not less than 0.03 in. draft over the fire at all times is one of the best investments imaginable, as it would pay for itself many times in a week.

Some Reasons for Boiler Accidents

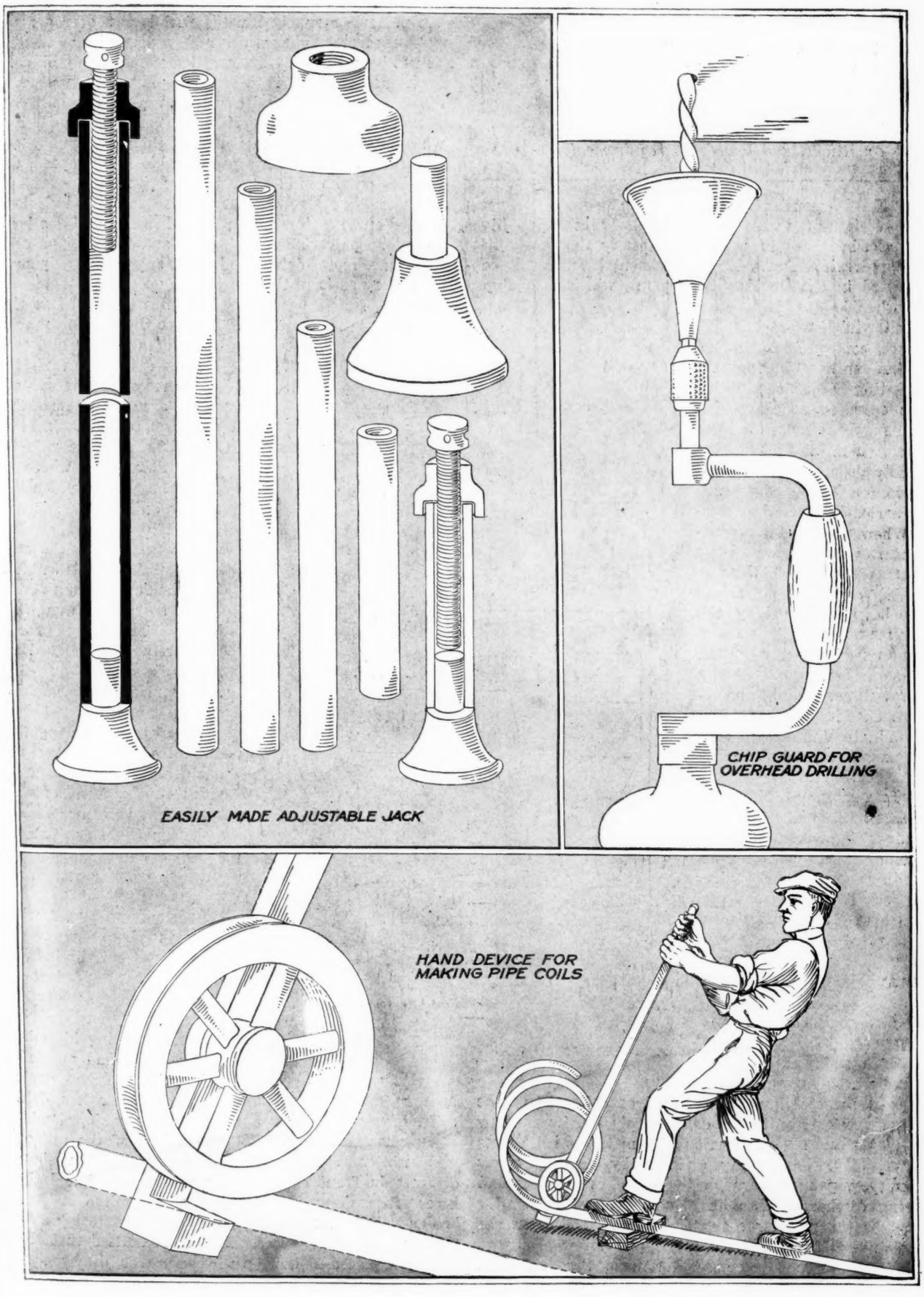
The illustrations below serve as forcible reminders of the necessity for cleanliness of boilers and their appurtenances, also that the old trick of loading the safety valve is still practiced. The photographs were taken by the California Accident Prevention Commission and are reproduced here by its permission.



FIGS. 1 TO 3. SOME GOOD REASONS FOR BOILER ACCIDENTS

Fig. 1—Tubes heavily scaled. Fig. 2—Safety valve made inoperative by accumulation of scale. Fig. 3—The old trick—Overweighted safety valve

Some Handy Tools for the Power Plant



Excellent Results with Pulverized Coal at Milwaukee

On 468-hp. water-tube boiler gross efficiency of 85.22 per cent. and net efficiency of 81 per cent. were obtained. No slag or ash troubles. Advantages are ease of control, ability to take overload quickly, uniform efficiency, ideal banking conditions, and low draft requirements.

IN ITS constant endeavor to improve boiler-room efficiency the Milwaukee Electric Railway and Light Co. has been investigating recently the possibilities of pulverized fuel. The experimental work was conducted in the Oneida Street plant, which is equipped with 500-hp. Edge Moor water-tube boilers and cross-compound vertical engine units. During the heating season the station is operated noncondensing to supply exhaust steam to the central district heating system operated by the company. During the early part of this year the necessary equipment for preparing and feeding the coal was installed and one boiler was equipped to burn pulverized fuel. Early in May the boiler was placed in service, and until August, when the installation was finally proved successful, numerous changes were made to eliminate undesirable conditions encountered during the preliminary operation.

In a room near the plant coal bunkers and drying and pulverizing equipment were installed, consisting of an indirect-fired drier having a capacity of 15 tons per hour and two pulverizers, one rated at four tons and the other at eight tons per hour. This equipment was intended for an installation of five boilers. The other four are to be equipped with burners and feeders in the near future. From one of the coal bunkers the fuel as delivered to the plant was carried to the drier supply bin by a screw conveyor and bucket elevator. From the bin coal was drawn into the drying cylinder by another screw conveyor, passing through the drier by gravity and being discharged into an elevator carrying the dry fuel to the pulverizer supply bin. In the drier the moisture is reduced from 11 to 1 per cent. at the rate of about 10 tons per hour. Between the drier and the pulverizer supply bin the fuel is run over a magnetic separator pulley which removes such iron and steel as has been carried that far. From the supply bin last mentioned the fuel is fed to the pulverizer through a small screw conveyor located on top of the mill and driven from the mill shaft by means of a small belt whose speed can be varied through a cone-pulley arrangement. This allows for variable feeder speed, depending on the kind of coal being powdered.

By another screw conveyor the pulverized fuel is carried on to a storage bin located in front of the boilers. The pulverizing equipment and the various conveyors are motor-driven and so arranged that only such machinery as is in the use will be operating.

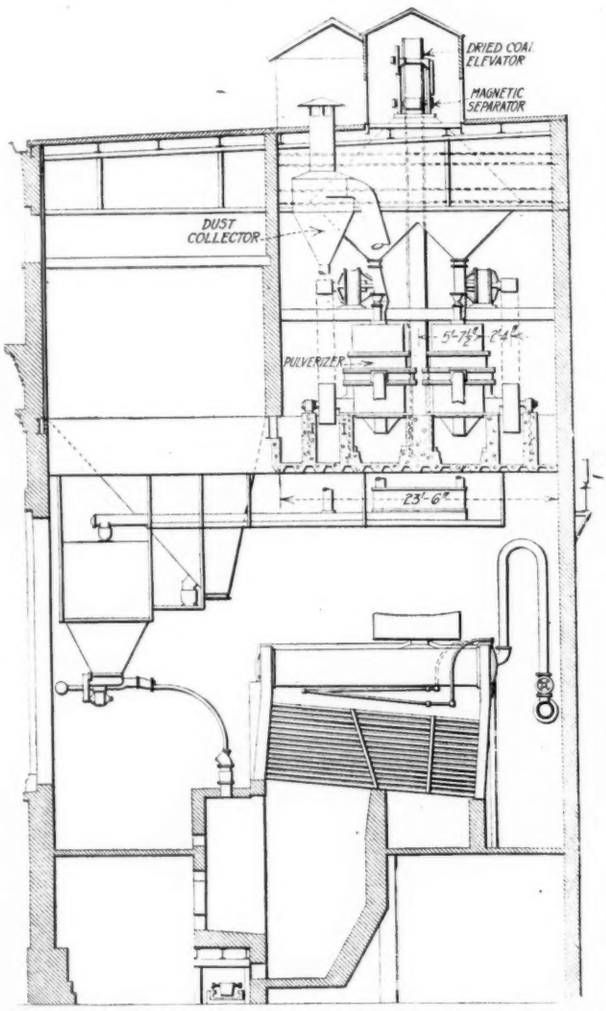


FIG. 1. SECTION THROUGH BOILER AND PULVERIZER PLANT

To fire the fuel into the furnace the equipment consists of a blower and two screws, driven by variable-speed motors. The screws, which are at the base of the powdered-coal bin, carry the coal at a uniform rate to the feeder pipes, where it is thoroughly mixed with air by agitator wheels attached to the end of the screw shaft. From the paddlewheel the fuel is carried into the furnace by the air blast supplied from the blower. The latter is comparatively small and does not begin to supply all the air required for complete combustion, about 95 per cent. of the air being induced by the stack through dampered openings provided at the front of the furnace. In the present installation there are twelve 10½-in. openings, all or part of which are used according to the requirements.

Reference to Fig. 1 will show the boiler to be a three-pass vertically baffled Edge Moor provided with three drums. The furnace was originally installed in 1898 for burning bituminous coal and had approximately 70 sq.ft. of grate area in an underfeed stoker. The boiler has 4685 sq.ft. of steam-making surface and is equipped with a superheater. Very little remodeling of the setting was necessary. A mixing oven extending a short distance in front of the boiler was provided and the inner corner formed by the floor of the ashpit and the bridge-wall was rounded out, the ashpit thus being utilized as combustion space. It will be noticed that the burner is placed at the top of the furnace, discharging

the coal downward. Its height is such that the flame lacks 5 or 6 ft. from coming in contact with the floor of the ashpit, so that the ashes drop through a relatively cooler zone and form a light powder which, with small slugs of slag, is raked out through the door at the bottom into a bucket conveyor provided for its removal.

The furnace volume is approximately 1700 cu.ft., allowing at normal rating of the boiler slightly less than 1 cu.ft. of volume per pound of coal burned per hour. The furnace, however, will give just as efficient results at 200 to 300 per cent. of rating, so that the ratio, perhaps, might be better described as 4 cu.ft. of furnace volume per 10 sq.ft. of steam-making surface. The coal feeders and burners are of the "Lopulco" type. Sectional illustrations of the feeder and the burner are shown in Figs. 2 and 3.

As to the operation of this system and the results obtained in the official acceptance test, the following comments were made by John Anderson, chief engineer

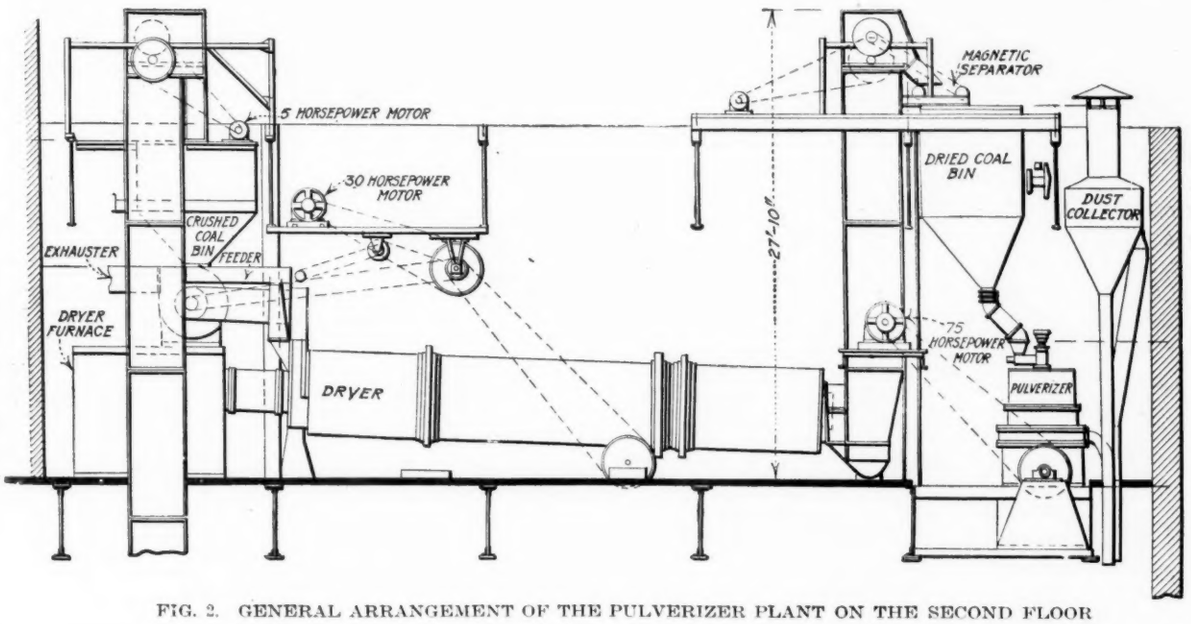


FIG. 2. GENERAL ARRANGEMENT OF THE PULVERIZER PLANT ON THE SECOND FLOOR

of power plants for the Milwaukee Electric Railway and Light Co., before a meeting of railway stationary power-plant engineers called by the conservation section of the United States Railroad Administration. When the boiler was first put into operation a number of undesirable conditions developed. An insufficient air supply caused high furnace temperature, resulting in fusion of the ash particles and a consequent accumulation of slag between the tubes, on the furnace walls and in the ashpit. The removal of this molten slag presented a difficult problem. It was also found that the combustion chamber was originally of insufficient size, so that high gas velocities resulting from insufficient air tended toward destruction of the refractory surfaces of the furnace. The combustion chamber was therefore enlarged and a regulated air supply was provided for by means of a number of auxiliary air openings equipped with dampers. Accumulation of slag in the pit was prevented by raising the point of admission of the fuel into the furnace so that the flame lacked 5 or 6 ft. from touching the base of the pit. As a result the particles of ash dropping from the flame did not fuse and could be easily drawn from the pit in the form of a powder and small slugs of slag. Subsequent analyses showed that the ash contained practically no carbon.

With satisfactory furnace conditions a series of preliminary efficiency and capacity tests were conducted. The brickwork was given a thorough trial by carrying the boiler at a continuous rating of 180 per cent. over a period of several days. On Aug. 12 and 13 a final efficiency test, the results of which are published herewith, was run.

Due to the nature of the equipment the coal could not be weighed on the firing floor. To arrive at exact figures it was necessary to run all drying and pulverizing equipment free of coal. The fuel in the pulverized storage bin was run to as low a level as possible and a measurement taken to determine the cubical contents of the powdered coal on hand at the start. Coal for the test run was weighed into the system at the moist-coal bunker, and at the close of the run the starting conditions, so far as was possible, were again established. Samples for analyses upon which the test results are based were taken at the moist-coal bunker as the coal was weighed in. Moisture samples were also taken at the feeder delivering to the pulverizer and at the burners.

During the test the feed water was weighed on standard tank scales of 2000-lb. capacity each. All feed-pump gland leakage was accounted for in the way usually adopted in standard boiler tests. All temperatures and pressures were taken with instruments that had been previously checked with standards. The blowoff piping on the boiler was disconnected so as to insure against any possible loss of water. The flues were blown five times during the 24 hours. Flue-gas analyses were made by means of an Orsat. Throughout the test uniform conditions were maintained. The speed of the coal feeders and the draft carried were held constant. The feed-pump speed had to vary somewhat from time to time, the variation in the rate of evaporation being due to slight changes in the quality of coal during the test run.

In looking over the test data it will be noticed that an evaporation from and at 212 deg. of 9.47 lb. of water per pound of coal was obtained. The average temperature of the feed water was 157.2 deg. F., the operating steam pressure 167 lb. gage, and the superheat 74.9 deg. F. The fuel used was screenings of three different varieties, which in the tabulated test data are numbered from 1 to 3. The B.t.u. in the three lots of coal as received averaged 10,779 and the B.t.u. dry, 12,045. During the test a total of 24 tons of coal was burned, averaging one ton of coal per hour.

A noticeable feature is the small amount of draft required. There is, of course, no fuel bed and the drop through the boiler when using a relatively small volume of air is practically negligible. In the combustion chamber and the first pass the vacuum was practically nil, or at least so small that it could not be read on a gage calibrated to 0.01 in. In the second pass the draft was 0.0057 in. and at the uptake 0.0975 in. It was noticeable that there was no accumulation of slag on the tubes, no pulsation, and that the brickwork was not affected by the heat of combusion.

The deductions made for fuel preparation are interesting. Under the drier 1140 lb. of coal was burned. The power requirements for the pulverizers, the various conveyors, the feeders and the fans were 449.3 kw.-hr., reducing on a basis of 3 lb. of coal per kilowatt-hour, to 1348 lb. of coal. The total deduction, then, is 2488 lb. of coal, which, at $5 per ton, would amount to $6.22. As 24 tons of coal were used in the test, the fuel value for preparation reduces to 26c. per ton.

Although no deductions were made for standby losses in the drier, attention is called to the fact that the drying and pulverizing equipment was designed for a five-boiler plant, and that when working to capacity, more

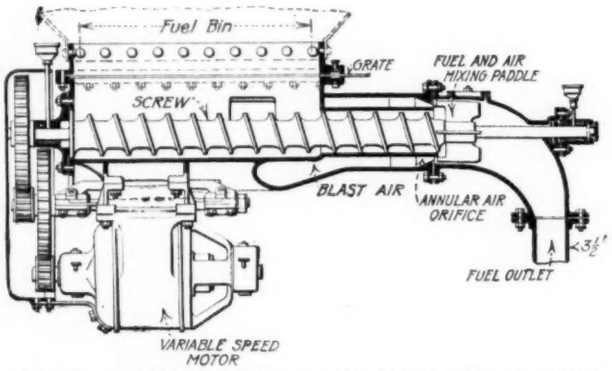


FIG. 3. VARIABLE-SPEED PULVERIZED-FUEL FEEDER

efficient results would be obtained than from the intermittent operation made necessary in serving only one boiler.

In conclusion, Mr. Anderson gave an interesting comparison between pulverized-coal equipment and mechanical stokers. In crushing the coal the expense is the same for both types of equipment. Although no daily operating records are available at present, Mr. Anderson estimates the cost of drying and pulverizing the coal at 32c. per ton on a 200-ton per 24-hour plant using bituminous coal containing about 12 per cent. moisture. In the test it will be remembered that the fuel value for preparation amounted to about 26c. per ton. Daily operating figures would of course vary somewhat from those obtained under test conditions. Maintenance costs on the drying and pulverizing plant had not been determined, but it was estimated that 3c. per ton would cover this item. In stoker practice the maintenance cost was close to 5c. per ton of fuel fired.

With coal at $5 per ton it was estimated that the gross efficiency shown by the pulverized-fuel boilers would have to exceed that shown by the mechanical

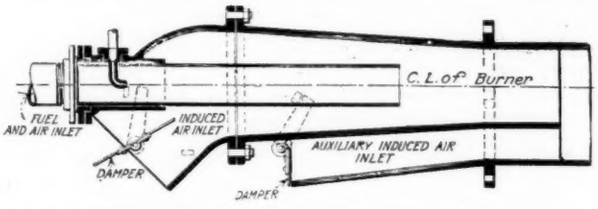


FIG. 4. BURNER FOR PULVERIZED COAL

stoker-fired boilers by 6 per cent. to offset the coal-preparation costs. Again, a conservative allowance was made for daily operating conditions versus the test data. Deducting 6 per cent. from the gross efficiency of 85.22 per cent. would leave a net efficiency of 79.22 per cent. for the powdered-coal burners. In stoker practice the maximum obtainable gross efficiency at any of the company's plants had been 80.54 per cent., the daily average being in the neighborhood of 76 per cent. Deducting 2½ per cent. for auxiliary uses, which is somewhat lower than the average, the resulting net efficiency is 78.04 per cent., or 1.18 per cent. lower than the figure obtained in pulverized-fuel practice.

This small gain in efficiency was only a part of the advantages resulting from the use of pulverized fuel. Other advantages Mr. Anderson summarized as follows: Continuous boiler operation at a uniform rating as well as constant efficiency. At no time is there a loss in capacity due to the clinkering of coal on grates or cleaning fires, nor are difficulties experienced from a change in the fuel as it comes from the bunker, necessitating different operating conditions at the stoker. Heavy overloads can be taken on or dropped off in an unusually brief time through adjustment of the coal feeders and the furnace draft. From 97 to 98 per cent. of the combustible in the coal is utilized regardless of the quality of the fuel. The ash-handling costs are reduced to a minimum due to the reduced volume.

When operating with pulverized fuel, the banking conditions are somewhat different from those obtained in stoker practice. By stopping the fuel supply and closing up all dampers and auxiliary air inlets, a boiler can be held up to pressure for at least ten hours. To illustrate, when running one of the preliminary tests the boiler had been shut down at 9 o'clock at night with 175 lb. steam pressure and at 7 in the morning there was still 155 lb. pressure and the brickwork was hot enough to ignite the coal from the burner. In stoker practice it is necessary to leave the damper slightly open to supply air and prevent gas explosions, so that much of the heat in the banking coal and from the brickwork passes up the stack rather than into the boiler.

The ease of controlling the fuel feed and draft, the ability to take on heavy overloads in a brief time, the thorough combustion of the coal and the uniform high efficiency obtainable under normal operation make pulverized coal a satisfactory form of fuel for central-station use. For operation month in and month out it

was Mr. Anderson's opinion that pulverized fuel would show a net gain of 10 per cent. over the previous way of operating.

As to maintenance, indications were that no unusual difficulties would be encountered. The cost of fuel preparation and labor for operating a boiler room fully equipped with pulverized-coal burning boilers would be a question for the engineer to determine himself, according to the particular conditions, whatever they may be in that plant. One predominant factor justifying the use of pulverized fuel was the ease with which a high efficiency could be obtained and the constant nature of that efficiency as compared to the variation in a stoker-fired boiler unless it was closely supervised. There was little doubt that with a well-equipped plant burning pulverized fuel and having all the necessary recording and indicating instruments to guide the operator in maintaining proper conditions, a lower cost of generating steam would be possible than has heretofore been obtained with any type of equipment.

It is interesting to note that the company that Mr. Anderson represents is equipping four more boilers with the same type of apparatus. The furnace as developed is considered standard and highly efficient operation is expected. When additional information has been obtained from the complete plant and initial costs are available, data based on actual operation will be of exceptional interest. These data, as soon as available, will be published in *Power*.

LOG OF OFFICIAL TEST AT ONEIDA STREET STATION

Day	Monday and Tuesday	Date	Aug. 12-13, 1918	
Make of boiler	Edge Moor	Rated hp		468
Heating surface, sq.ft				4,685
Time fired or test started		11:15 a.m.,	Aug. 12,	1918
Time fired out or test finished		11:15 a.m.,	Aug. 13,	1918
Duration of test, hours				24
Temp. of boiler room, deg. F	Max. 99	Min. 85	Av.	93.30
Temp. of feed water, deg. F	Max. 188	Min. 135	Av.	157.20
Temp. of steam, deg. F	Max. 477	Min. 427	Av.	448.70
Barometer, in. of hg	Max. 29.35	Min. 29.20	Av.	29.25
Temp. of flue gases, deg. F	Max. 515	Min. 455	Av.	495.30
Ave. boiler pressure, lb. gage				167.0
Atmospheric pressure, lb				14.4
Temp. of steam, cor. to press., deg. F				373.8
Superheat, deg. F				74.9
Safety valve set for 175 lb.				
Fuel fired per hour, lb	1990.6	Bituminous		100%
Total fuel				47,775
Total water, lb				393,168
Water apparently evaporated per hour, lb				16,392
Water apparently evaporated per pound of coal, lb				8.23
Factor of evaporation				1.1502
Water evaporated f. and a. 212 deg. F., per lb. of coal, lb				9.47
CO_2, per cent. max	15.4	Min., 12.20	Av.	13.85
O, per cent., max	5.6	Min., 3.20	Av.,	4.38
CO				None
Fuel used, kind				Screenings

Fuel analyses:	No. 1	No. 2	No. 3	Av.
Moisture	10.3	11.0	9.7	10.49
Volatile	33.81	36.96	39.77	35.96
Fixed carbon	50.43	49.13	48.29	49.53
Ash	14.36	13.91	12.94	13.93
Sulphur	1.99	2.06	2.12	2.04
B.t.u. as received	10,600	10,763	11,263	10,779
B.t.u., dry	11,817	12,093	12,473	12,045
Pounds of coal	19,775	20,000	8,000	
Percentage of total	41.3	41.9	16.8	

Vacuum in combustion chamber				0.00
Vacuum in first pass				0.00
Vacuum in second pass, in				0.0057
Vacuum in breeching uptake, in				0.0975
Feeder speed, r.p.m	No. 1, 53.6	No. 2,		50.7
Coal per rev. of screw, lb				0.318
Accumulation of slag on tubes				None
Accumulation of ash in settings	Flues blown five times during test			
Operation of furnace	Very satisfactory			
Pulsation				None
Condition of smoke				Light
Heat effect on brick				None
Backlash of flame in burner				None
Lb. steam per hour				16,390.3
Lb. steam per hour, f. and a. 212 deg. F				18,842.6
Horsepower				546.2
Per cent. of rating				116.7
Boiler efficiency				85.22
Memoranda: Fuel preparation deductions				
Coal used in dryer, lb				1,140
Kilowatt-hour motor operation (449.3) coal equivalent at 3 lb. per kw.-hr				1,348
Total deduction, lb				2,488
Resulting net efficiency, per cent				81

No deduction made for stand-by losses in dryer.

Defective Power Belts

Although a sale of a driving belt for use on machinery involves an implied warranty on the part of the seller that the belt is reasonably well adapted to its intended use, the buyer is not entitled to a cancellation of his purchase after having continued to use the belt after discovering a claimed defect in it.

The Mississippi Supreme Court applied this rule the other day in the case of Lumbermen's Supply Co. vs. Poplarville Sawmill Co., 78 Southern Reporter, 157, in which defendant denied liability for the price of a belt that was found to be unsatisfactory. Deciding the case in plaintiff's favor, the court said:

If there was a failure of warranty in these respects, defendant should have rejected and returned, or offered to return, the belt within a reasonable time after he discovered such condition; otherwise the implied warranty was terminated by the acceptance. This he failed to do, and he cannot now repudiate the contract, after having had valuable and continued use of the belt with knowledge of its objectionable condition.

Seller's Warranty of Steam Appliances

In a suit lately passed upon by the Appellate Term of the New York Supreme Court (Godfrey Keeler Co. vs. Tarrytown Hygeia Ice Co., 171 New York Supplement, 179), the plaintiff sued to recover the price of a steam pressure regulator. Defendant resisted liability on the ground that the appliance was sold under a warranty that it would operate on a variance of one pound pressure and that as the pressure increased the regulator would gradually close, that the device failed to meet this warranty, and that defendant had notified plaintiff it would not be accepted.

The court sustains defendant's claim in this respect, but reversed a decision of a lower court, holding that, in addition to rescinding the contract, defendant was entitled to recover damages to cover the expense of reëmploying a foreman who had operated its plant before the purchase of the regulator. Deciding that this item of expense "in sense constituted damage which defendant suffered by reason of plaintiff's breach of warranty," the court holds: "Plaintiff sold an article warranted to do certain work, and on its failure to conform to the warranty, the defendant had the right either to rescind the sale or to keep the regulator and recover the difference in value of the article as sold and the article as actually delivered."

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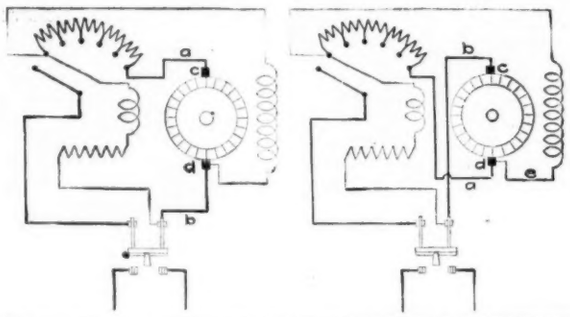
These are American soldiers in France; they must be clothed and equipped; $150 in Liberty Bonds does this for just one man.

The Electrical Study Course—Reversing Rotation of Motors

Treats of the various factors that must be borne in mind when making the changes in connections required to reverse the direction of rotation of shunt, series and compound motors.

IT IS sometimes necessary to reverse the direction of rotation of motors. In fact, when a motor is set up for the first time its direction is as likely to be opposite to that desired as otherwise. When undertaking to change the connections in order to reverse the rotation, it is well to observe certain precautions. Take, for example, the case of the shunt motor. Assume that the connections have been made correctly as in Fig. 1, and that the motor is found to revolve in the wrong direction. We know that the direction of rotation can be changed by reversing either the current through the armature or that through the field coils. It would therefore appear that reversing either the armature or field connections would effect the desired change. This conclusion would, however, be incorrect as regards the armature connections, as may be seen by reference to Fig. 2, in which lead *a* of Fig. 1 has been transferred from



FIGS. 1 AND 2. SHUNT MOTOR CORRECTLY CONNECTED FOR FORWARD ROTATION AND INCORRECTLY CONNECTED FOR REVERSED ROTATION

brush *c* to brush *d* and lead *b* from brush *d* to brush *c*. It will be seen that the field is now incorrectly connected, being connected in multiple with the resistance of the starting box, under which conditions the motor may not be started as explained in the last lesson; to make the machine operate properly it would be necessary to transfer lead *e* from terminal *d* to terminal *c*. On the other hand, reversing the field connections as indicated in Fig. 3 is permissible since no change other than the reversal of the current through it results therefrom. It is therefore preferable to reverse the field connections rather than those of the armature when it is desired to reverse the direction of rotation of the motor. Moreover, the armature leads are of much heavier wire than the field leads, and in the case of large motors their manipulation is a matter of considerable labor.

Reversal of rotation in a series motor is very simple since the field winding is directly in series with the armature. It is immaterial whether the armature or the field connections be the ones reversed, as they both carry the same current. If, therefore, the connections were originally those shown in Fig. 4, the direction of rotation of the motor could be reversed by making a change of connections in accordance with either Fig. 5 or Fig. 6.

When undertaking to reverse the rotation of compound motors, care must be exercised that the field windings shall remain connected for cumulative excitation

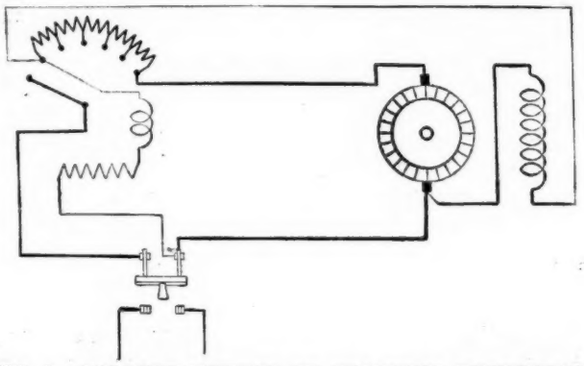
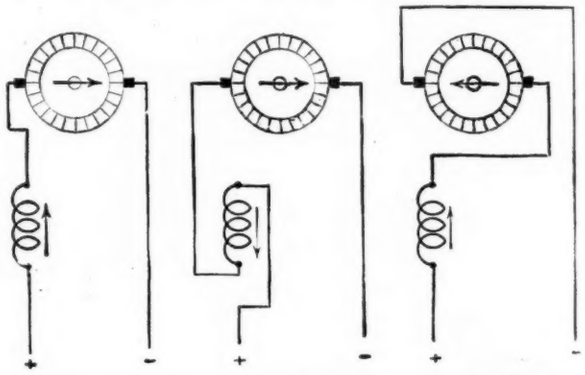


FIG. 3. CORRECT METHOD OF CHANGING CONNECTIONS TO REVERSE DIRECTION OF ROTATION OF SHUNT MOTOR

after whatever change that is made in connections has been effected, besides taking the same precautions that are required when dealing with shunt motors. In the case of the latter it was found to be more practicable to reverse the field connections than the armature connections, but in the case of the compound machine it will be found that a change of armature connections will involve slightly less trouble than one of field connections. Let Fig. 7 represent the connections as they exist at first; Fig. 8 will then show the changes that would have to be made if reversal of rotation is to be effected by reversing the current through the field coils, and Fig. 9 those required if it is to be effected by reversing



FIGS. 4 TO 6. CONNECTIONS FOR FORWARD AND REVERSE DIRECTION OF ROTATION OF A SERIES MOTOR

the current through the armature. In the first case lead *a* would have to be transferred from terminal *e* to terminal *f*, lead *b* from *f* to *e*, lead *c* from *k* to *l*, and lead *d* from *l* to *k*. In the second case lead *b* would have to be transferred from terminal *g* to terminal *h*, lead *m* from *h* to *g*, and lead *d* from *h* to *g*. That is, in one case the two leads of the series-field winding and the two of the shunt-field winding would have to be changed,

whereas in the other case the two leads from the armature would have to be changed, but only one of those of the shunt-field winding. Consequently, the latter method would be somewhat simpler as requiring only three changes as compared with four in the other case.

Motors of the foregoing types which have interpoles in addition to the main field windings must be treated

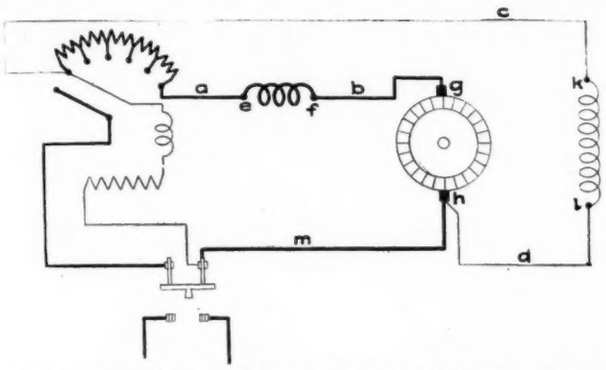


FIG. 7. CONNECTION DIAGRAM OF A COMPOUND-WOUND MOTOR AND STARTING RHEOSTAT

in the same manner as those without them. The interpole windings are usually connected into the armature circuit of the machine permanently, and it should be understood that when applying any of the foregoing directions to interpole motors the armature terminals must be considered as including the interpole windings. For example, in Fig. 10 the armature terminals would be *a* and *c*, not *b* and *c*. If the interpole field windings have for any reason been disconnected from the armature, care must be exercised that they be reconnected in the correct manner, after which they should be treated as a unit, as just explained. Means for determining the proper direction of the connections will be discussed a little farther on.

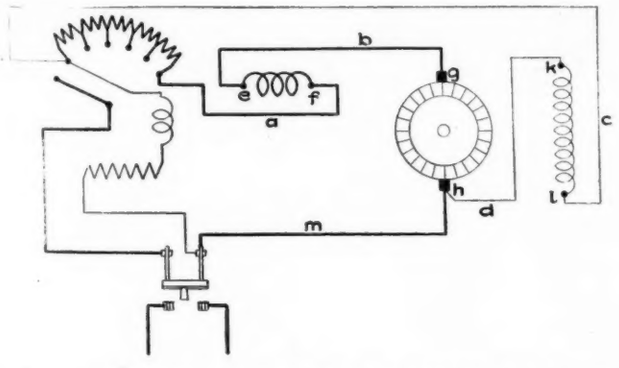


FIG. 8. REVERSING DIRECTION OF ROTATION OF COMPOUND MOTOR BY CHANGING FIELD CONNECTIONS

Commutation must occur in motors as it does in generators. That is, as each coil in succession passes from the region of a north pole into that of a south pole, or vice versa, the commutator bars to which it is connected pass under one of the brushes, and when they emerge on the other side the direction of the current through the coil will be the opposite from what it was. In the case of generators it was found that there would be considerable sparking at the brush at the instant the commutator segment passed from under it if a current had not previously been generated in the coil while it was short-circuited by the brush, the direction of the current being the same as that which it would have after passing the brush. In order to make such a current flow it was found necessary to move the brushes away from the neutral axis in the direction of rotation so that the coil might be cutting sufficient magnetic flux to induce the voltage necessary for the purpose. In the case of motors the brushes must be moved away from the neutral axis in a direction opposite to that in which the armature is revolving in order to secure sparkless commutation. This is so because the direction of current through the armature must be opposite from what it is in a generator for the same direction of rotation and of field flux. Since the brushes must be moved back from the neutral axis, or given an angle of lag as it is known, it follows that when the direction of rotation is reversed the brushes must be shifted to the other side of the neutral axis by the same angle they had in the first direction. If the brush-holders are of a type which stub or chatter when the commutator turns in a direction opposite to that for which they are set, it is necessary to reverse them if the direction of rotation is to be reversed. In that event the entire brush-holder rig must be moved through a considerable angle to make the brushes occupy their correct position. In Fig. 11 is represented the position of the brushes of a two-pole motor when the armature revolves in the direction of the arrow *A*. If it is required to reverse the direction of rotation, the brush-holders *m* would have to be removed from their studs *n* and reversed to occupy the position shown in Fig. 12. The brush-holder rocker would then have to be moved around the commutator until the brushes occupied the position they have in Fig. 13. The

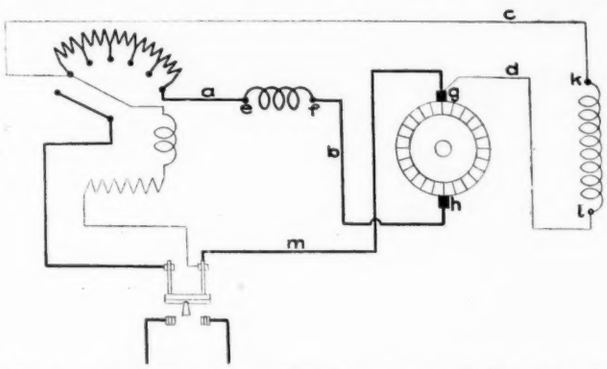


FIG. 9. REVERSING DIRECTION OF ROTATION OF COMPOUND MOTOR BY CHANGING ARMATURE CONNECTIONS

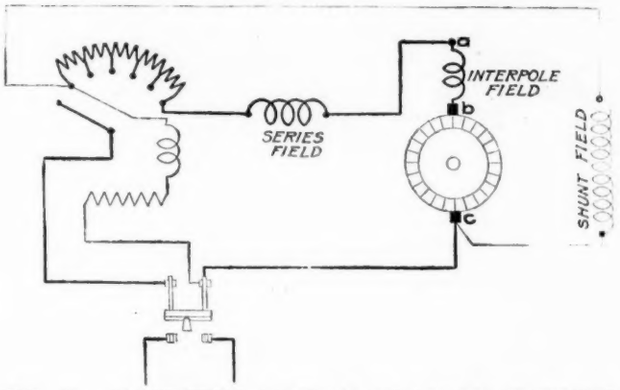
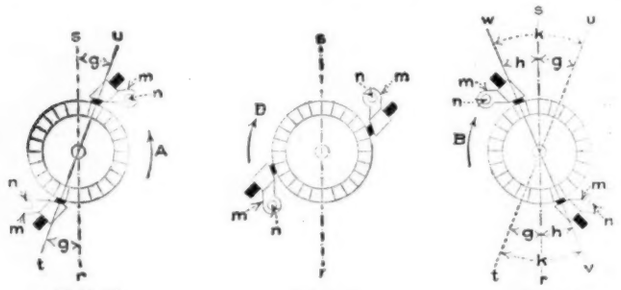


FIG. 10. CONNECTION DIAGRAM OF COMPOUND-WOUND MOTOR WITH COMMUTATION POLES

neutral axis passes through *rs* and in Fig. 11 *tu* represents the line passing through the center of the brushes. The angle *g* which *tu* makes with *rs* is called the angle of lag, and for reversed rotation the brushes must be swung around the commutator through the angle *k* until the line *tu* occupies the position *vw* as in Fig. 13, such that the angle *h* is equal to the angle *g*, which will give the same angle of lag as before. There is no ready way of accurately locating the neutral axis of a machine, so that it would not be an easy matter to determine just what angle *k* the rocker should be turned through. However, on such machines as require brush reversal for reversal of rotation, the manufacturers furnish markings on the rocker and on the stationary frame adjacent to indicate the proper positions. In the event that there are no such markings, the position of the brushes on the commutator should be noted, and after changing around the brush-holders they should be moved until they are a few commutator segments from their former location in the direction opposite to the one in which the armature is to revolve, care being taken not to move the armature while making the changes. The brush-holders may then be adjusted until the best commutation is secured; that is, until a position is found which gives the minimum of sparking for all loads within the range of the motor.

Many motors are fitted with brush-holders that operate equally well for either direction of rotation. If the machine is of the interpole type, commutation is taken care of automatically and the necessity of providing an angle of lag is obviated; and if such a machine is fitted with brush-holders as just described, it will run equally well in either direction without adjustment of the



FIGS. 11 TO 13. CHANGES NECESSARY IN BRUSH-HOLDER SETTING TO EFFECT REVERSAL OF ROTATION OF A MOTOR

brush-holders. Reversing motors, that is, such machines as drive loads which require to be reversed, are usually of this type. Before the advent of the interpole type of machine reversing motors were constructed up to fairly large sizes by using special designs of magnetic circuits and high brush-contact resistance to secure satisfactory commutation with the brushes on the neutral axis, but the development of the commutating pole has simplified the problem greatly. When shunt or compound machines are used for such service, it is preferable to reverse the direction of the current through the armature rather than through the shunt field since in reversing the latter the magnetic flux would have to be brought to zero and up again, whereas in the former case the field current could be allowed to remain constant throughout.

In the problem of the last lesson it was required to determine the size of motor necessary to hoist a load of 3 tons through a vertical distance of 600 ft. in 1½ minutes, neglecting such losses as might occur in the mechanism. It was further required to find the current the motor would take if it were a 500-volt machine and had an efficiency of 90 per cent. at the load specified; also what type would be best suited to the service. Since a ton contains 2000 lb., the weight to be hoisted would be $3 \times 2000 = 6000$ lb. To lift this weight through

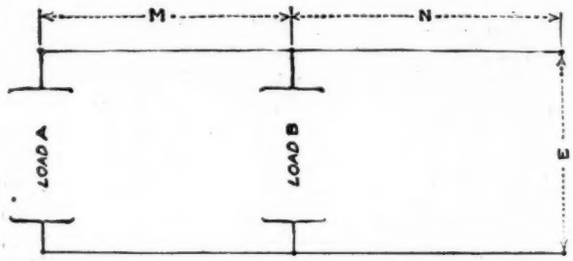


FIG. 14. PROBLEM INVOLVING LOADS CONNECTED IN MULTIPLE ACROSS A CIRCUIT

600 ft. would require the expenditure of $600 \times 6000 = 3{,}600{,}000$ ft.-lb. of work. If it is performed in 1.5 minutes, it would be at the rate of $\frac{3{,}600{,}000}{1.5} = 2\,400{,}000$ ft.-lb. per minute. One horsepower = 33,000 ft.-lb. per minute, consequently the power required would be $\frac{2{,}400{,}000}{33{,}000} = 72.7$ hp. If the efficiency is 90 per cent., we have that $72.7 = 0.9\ P$, where P is the horsepower taken by the motor; hence $P = \frac{72.7}{0.9} = 80$ horsepower.

To find the current required at 500 volts to supply this amount of power we multiply the number of horsepower by the watts in 1 hp., which gives us $80 \times 746 = 59{,}680$ watts, which divided by the voltage gives $\frac{59{,}680}{500} = 119$ amperes. A compound-wound motor would be the most satisfactory for the service, since it would provide a large starting torque on account of the strong magnetic field created by the large starting current through the series-field windings, and yet after starting a uniform speed of lift would be maintained.

The system indicated in Fig. 14 has a load of 109 fifty-watt, 110-volt lamps at *A* and one of 76 sixty-watt 115-volt lamps at *B*. The line *M* is of No. 8 wire and is 81 ft. long; the line *N* is of No. 4 wire and is 205 ft. long. The voltage *E* is 125 volts. Find the voltages at the loads *A* and *B*; also the total current required by the loads.

Every Houseworker Can Help Save Coal

"It is important to let every woman who does her own housework or who is engaged as a domestic know that she can help the Fuel Administration this winter in saving coal." This statement was made by Mercer P. Moseley, Chief of Conservation for the State of New York. "One way of tending a fire is wasteful, the other economical. Between these extremes individual skill will assert itself. Fires can be banked and cared for during the night, and at the end of a month a quarter or half ton of coal in each household can be saved. All that is needed is that the woman who shakes the fire and feeds it coal shall keep in mind the thought that she is helping this country every time that she saves coal."

Fundamental Principles in the Development of Water Power

By DAVID R. SHEARER

A description of the points to be considered in developing the water power of a stream, explaining the calculation of flow, theoretical horsepower and the causes of variation of stream flow.

THE earlier water-power developments were very crude and the wheels, in most cases, absorbed only a small part of the actual energy in the current of a flowing stream. However, engineering knowledge and a study of the laws of nature have raised the efficiency of waterwheels and water-power accessories from about 20 to 30 per cent. of the actual power in the minimum flow of a stream to 80 or 90 per cent. of the power of average stream flow.

Primarily, water power is dependent on two factors: The head, or difference in elevation between two points on a stream, and the flow, or weight or volume of water passing in a given time from the higher elevation to the lower. The maximum available power, based on these two factors, is given by the formula

$$H = \frac{62.5 \times h \times q}{550}$$

in which

H = Horsepower of stream;
h = Head, in feet;
q = Flow, in cubic feet per second.

This equation represents the theoretical power of the water; but since there can be no mechanical transformation of energy without loss, it becomes necessary to add another expression to the formula to represent

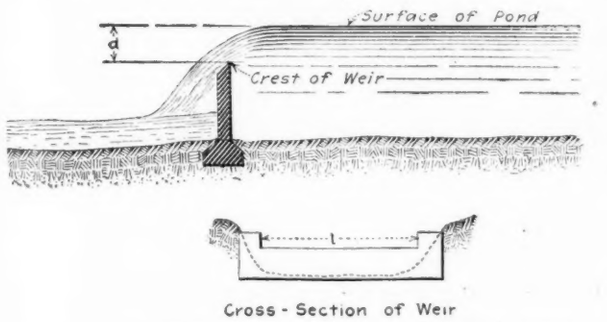


FIG. 1. MEASUREMENT OF WATER FLOW BY WEIR

the efficiency expected from the waterwheel and accessories. For rough calculations this efficiency is assumed to be 80 per cent., so that the formula becomes

$$H = \frac{62.5 \times h \times q \times 0.80}{550}, \text{ or } H = \frac{h \times q}{11}$$

Thus it is possible to determine the approximate water power at a given site by multiplying the head or fall in feet by the flow of water in cubic feet per second and dividing the product by 11. The head is usually easily found by the means of a level, but the flow is not so readily determined, as may be seen by examining the three methods of measurement that are in common use. If the stream is very small, it would be feasible to make a box of such size as to contain one or more cubic feet of water and, by diverting the flow to this receptacle, actually to measure the quantity passing in a given time. Obviously, this method is out of the question in most cases and some other means must be employed, such as measurement by a weir. This method is based on the fact that for any given depth of water over the crest of a dam a definite quantity will flow per second for each foot in length of the crest. The factors of flow have been experimentally determined and tabulated in the form of weir tables, which may be found in most catalogs of waterwheels and in many works on hydraulics and handbooks of engineering.

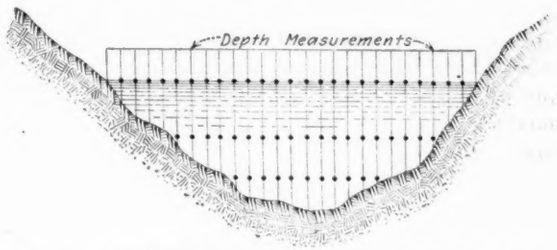


FIG. 2. MEASUREMENT OF WATER FLOW BY FINDING VELOCITIES AT VARIOUS POINTS

A weir is essentially a sharp-crested dam over which the water is caused to pass with sufficient fall to obviate any choking action of the dead water below. The measurements necessary for a quantity estimate are the length l of the weir crest, or notch, and the depth d of weir flow. This depth, as indicated in Fig. 1, is the elevation of the surface of the pond above the bottom of the notch in the weir and not the depth of water actually flowing over the crest. After these two dimensions are obtained, it is necessary only to refer to the tables and find the flow per foot of weir length for the depth observed and to multiply this factor by the length of that particular weir. The product is the flow in cubic feet per second.

Many streams are so large that the use of a weir would be either impracticable or very expensive. In such a case the area of cross-section of the stream is found by measuring the actual depth of the water at equal intervals between the banks, as shown in Fig. 2. To get the flow it is necessary only to find the average velocity of the water. This is done by measuring the velocity either with a current meter or with weighted floats at a number of points, as indicated by dots, and averaging the results by adding all the velocity measurements together and dividing by the number of measurements. Then, the average velocity multiplied by the sectional area gives the flow of the stream. In making the velocity measurements by weighted floats it is usual to measure the flow per minute and divide by 60 in order to get the flow per second.

It is comparatively easy to find the power of a given

stream at a definite time, but unfortunately few streams have anything approaching a uniform flow. It varies from day to day, from month to month, and even over periods of years. The variation is due to the fact that the flow of most streams is dependent on several factors, some constant, but most of them variable, as, for instance: (1) Area of watershed, constant; (2) rainfall, variable, dependent on season and year; (3) evaporation, variable, dependent on sun and weather; (4) run-off, variable, dependent on soil, vegetation, contour and season.

The variable factors are different for each locality, so that considerable study often is necessary to calculate the probable flow of a particular stream. Theoretically, of course, the average yearly flow in any stream is equal to the rainfall on the watershed in cubic feet less the evaporation in cubic feet divided by the number of seconds in a year. This information can usually be secured from the Government records covering several years and is very nearly true; but a little thought will show that it is impossible to utilize the average yearly flow without a very great storage capacity, for floods will come which cannot be used and so will be wasted. Thus it will be possible to secure power from only a part of the average yearly flow. If run-off records are available, they will prove desirable in determining the maximum economical power development; but by far the most useful data are the actual stream-flow measurements over a period of several years. The Government has kept stream-gaging stations in many parts of the country for several years, and data are available provided a station has been established on the stream under consideration.

In actual practice it is necessary to use all the water possible in the most economical manner, and this will usually require pondage and frequently auxiliary power in some other form, as can be noted from the study of the hydrograph shown in Fig. 3, which represents the flow of a certain stream throughout the year. It can be seen that if a plant were installed sufficient to develop the average flow, the flood waters would be lost and at other times the flow would not be sufficient to

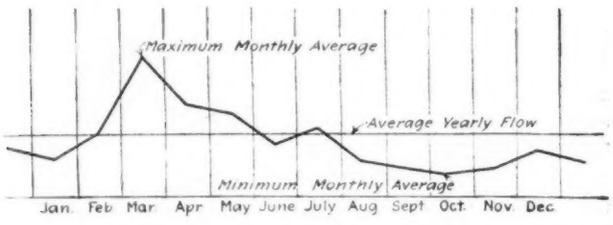


FIG. 3. VARIATION OF STREAM FLOW DURING YEAR

develop even half of the average power. But if auxiliary power, such as steam, were available for a few short periods in the year, it would be possible to develop almost the average yearly power. The requisite for such auxiliary power may be stated as follows: The use of a certain quantity of auxiliary power for short periods will permit the development of that amount of water power over much longer periods and so allow a more uniform production of power, which can be sold to consumers whose demands are in turn fairly uniform or constant.

Another fact now comes up for consideration, which is, that the power demand on a given water-power plant varies somewhat during the day, and in the case of a hydro-electric installation the power demand fluctuates greatly during the twenty-four hours. Perhaps the most nearly uniform load that can be placed on a waterwheel is that of a spinning or weave mill; but even with a uniform power demand of this kind there will be a drop in load for an hour in the morning, one at noon and one in the evening, with an increase in load at night when the lighting system is turned on.

At the present time most water powers are used for the purpose of generating electricity for use by the public or by private interests, and in either instance

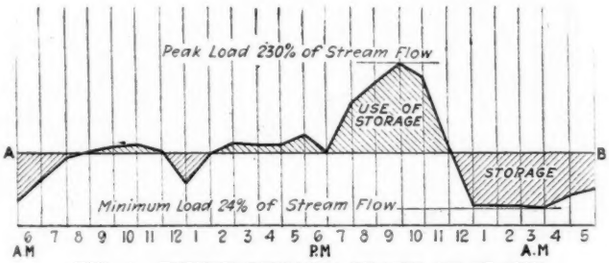

Peak Load 230% of Stream Flow
USE OF STORAGE
STORAGE
A
B
Minimum Load 24% of Stream Flow
6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5
A.M
P.M
A.M

FIG. 4. POWER-DEMAND GRAPH OF PLANT

the load demand varies materially. This fact makes the use of pondage a very desirable feature; for, the water flowing when the load is light may be stored to be used when the load is greater than can be developed by the average flow. Fig. 4 is a power-demand graph of a particular hydro-electric plant, assuming the stream flow and average load to be equal, and a study of it will indicate the following facts: The straight line *AB* is the average flow of the stream during the day reduced to kilowatts, the shaded areas below this line represent the storage of power in the pond, and the shaded areas above the line indicate the use of stored water during the peak power demands. Another point to be noted is that the pondage should be sufficient to store the flow for from twelve to eighteen hours so that the power developed may be at least twice the flow power for twelve hours, or three times the flow power for eight hours. Thus it is seen that a much larger wheel may be installed than could be run continuously by a given stream provided the demand is of a fluctuating character. In fact, practically all plants have wheels of much greater capacity than the average daily flow, and indeed should have, in order to operate economically.

Unless auxiliary power is available, or a storage pond large enough to carry excess water from season to season throughout the year, it is not possible to develop continuously more power than is afforded by the minimum yearly flow, and even this may be decreased by an extraordinarily dry year. The average stream will have from two to four low-water months when even the average power cannot be developed from the water; consequently, part of the load may have to be taken off the plant. This results in the division of the power produced by a plant into two classes, called primary and secondary power. Primary power is that which the given plant can produce continuously throughout the year without interruptions from low water. Secondary power may be produced for a certain period in the day or for a certain number of months in the

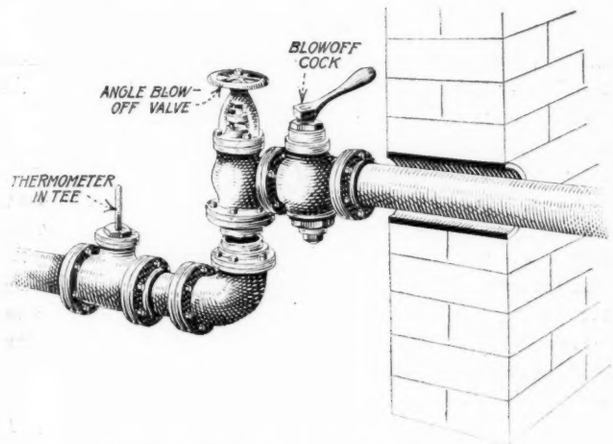
year. In the latter case a wet year may cause the secondary power to become as satisfactory as primary, or a dry year may make secondary power very nearly worthless.

From this brief survey it may be seen that the development of a particular water power is a question dependent on many variable factors. The best development is that in which all these factors are used most efficiently toward securing a desired result that has been previously determined from a study of power demands.

Boiler Blowoff Valves

By R. B. Dale

The most approved method of arranging the blowoff valves of a boiler is to place a valve and a cock in tandem, with the cock between the boiler and the valve, as shown in the illustration. This arrangement is required by the American Society of Mechanical Engineers Boiler Code. The reason for this tandem arrangement is to give the added protection of two valves and also to afford the gradual opening and closing qualities of a disk valve,



APPROVED BLOWOFF PIPING DESIGN

together with the rigid strength and security of a plug cock. A disk valve may be opened and closed slowly and gradually, but the seat is likely to be injured by closing down on sand or scale. The cock is opened quickly by a quarter turn of the handle, is substantial in construction and is not easily injured by sand or scale.

In blowing down it is generally recommended that the cock be first fully opened by giving the handle a quarter turn. Next, the valve is opened slowly to its full opening and allowed to remain in this position for the period of the blow. To stop blowing, the valve is first closed slowly and brought firmly to its seat, then the cock is closed by a quarter turn. One can sometimes tell by the "feel" of the valve handle if scale or sediment has lodged on the seat. By careful manipulation such accumulations may sometimes be crushed to such an extent that if the valve is again slightly opened the scale will be blown through. If it is apparent that scale has lodged on the valve seat, it is not wise to force the disk against the seat. If the scale cannot be crushed by careful work, it is best to close the cock and then remove the valve bonnet to enable the scale to be taken out by hand.

Care must be exercised in taking off the valve bonnet either for the purpose of removing sediment or to change or grind the disk or seat, for if the cock is worn it will leak and the operator is likely to be scalded. If the end of the blowoff pipe or header can be examined, an emission of steam when the valves are apparently closed will be an indication of a leak. Frequently, the arrangements are such that the discharge end of the blowoff cannot be examined. If the valve body remains hot for an unusual period after the blowdown, it is an indication that there is a leak past both valves; but if only the cock leaks, an accumulation of condensation between it and the valve will cool the valve body so that this test becomes inoperative. Probably the best indicator is a thermometer in the blowoff line on the discharge side of the valve, at any convenient point but as close to the valve as possible. A leaky cock may be detected by opening the valve while the cock remains closed and taking a reading about thirty minutes after a blowdown and comparing with a reading taken when the valves are known to be tight, for an excessive temperature will indicate a leaky cock. (This test is not to be relied upon if there is any chance for steam to back up in the pipe from other sources.) In a similar manner a leaking valve may also be detected. In this case the valve is closed and the cock allowed to remain open long enough to take the required readings. If both the cock and the valve should leak, the fact would also be indicated by the thermometer.

It is always best when removing a valve bonnet to assume that the cock leaks and to be cautious, because a very small leak will be sufficient to cause serious burns. The cock should never be tampered with when the boiler is under pressure. If a cock is known to leak, it should be repaired only when the boiler is down and the fires drawn. A leaky blowoff is wasteful of heat, therefore the trouble and expense of installing a thermometer cup in the discharge line and taking the necessary readings will be a good investment in these days of high coal prices.

Heat Stroke as "Accident"

Where a fireman employed at a power plant suffered a heat stroke while at work in a boiler room and died the following day, he is properly regarded as having died of "personal injury sustained by accident," within the meaning of the Rhode Island Workmen's Compensation Act. This is the gist of the decision of the Rhode Island Supreme Court in the recent case of Walsh vs. River Spinning Co., 103 Atlantic Reporter, 1025. The decision overruled a contention made on the part of defendant employer that the death should be attributed to "the disease of heat exhaustion."

In support of the conclusion reached, the Supreme Court, among other cases, refers to an English decision in which it was held that a marine engineer, who died of heat stroke while on duty and on the Red Sea, was the victim of an "accident'" within the terms of the British Workmen's Compensation Act. To a claim on the part of the employer in that case, that the heat was due to natural causes, because the Red Sea is always very hot, the sitting judge remarked that "evidence would not be required to prove that the engine room would be a hotter place than the open air."

Fusibility of Ash from West Virginia Coals*

By WALTER A. SELVIG
Of the United States Bureau of Mines

Information concerning the fusibility of coal ash has become of considerable interest to the consumer of coal during the last few years, principally in connection with the troublesome formation of clinker which results from the melting of the ash constituents of the coal when subjected to heat. The growing interest for such data has led the Bureau of Mines to make a general survey of the "fusing" or "softening" temperatures of the ash from well-known American coals. It is hoped that this information, when used together with the large number of coal analyses made available by the publications of the Bureau of Mines,[1] will be of help to the consumer in comparing the different coals and in the selection of the coal.

THE method employed for the fusibility tests was the standard gas-furnace method of the Bureau[2] The coal samples are ground to 60-mesh, with crusher rolls and ball mill. This 60-mesh material is then placed in shallow fireclay roasting dishes and completely ashed in a muffle furnace at a temperature of 800 deg. to 900 deg. C. (1472 to 1652 deg. F.). The resulting ash is ground in an agate mortar to pass a 200-mesh sieve. To make sure that the coal has been completely ashed, the ash after grinding is placed in fused silica capsules and ignited at 800 deg. C. (1472 deg. F.) for two hours, a current of oxygen gas passing through the furnace during the ignition period. This ignition is made to insure complete and uniform oxidation of the ash.

A portion of the ash is transferred to an agate mortar, moistened with a 10 per cent. dextrin solution and worked into a plastic mass with a spatula. The ash is then molded into solid triangular pyramids, $\frac{3}{4}$ in. high, and $\frac{1}{4}$ in. wide at the side of the base. These cones are removed from the brass cone mold, dried, and mounted in a vertical position in a refractory base made up of a mixture of two parts of kaolin to one part of calcined alumina. Usually, five cones are mounted in the same base. The base with the cones is dried carefully over the hot plate until all water is driven off, then the dextrin is burned out of the cones by igniting the mounted cones in a muffle furnace at a dull heat, after which the cones are ready for use.

The furnace used was the No. 3 melter's furnace. The cones supported by a suitable mounting are placed within a covered fireclay crucible in the furnace. A 2-in. hole is drilled through the furnace jacket and fireclay crucible for observation purposes, a fused silica tube carrying a thin glass window being placed in the observation hole. At right angles to the observation hole a $\frac{1}{4}$-in. hole is drilled through the furnace and crucible. Through this hole a platinum-platinum-rhodium thermocouple, protected by a glazed porcelain tube, is inserted. By proper adjustment of the gas and air, a reducing atmosphere is maintained within the furnace, this being accomplished by using the minimum amount of air necessary to attain the desired temperature. Under these conditions the iron in the ash is reduced to the ferrous state, which condition gives the lowest melting points and therefore gives the lowest temperature at which clinkering may result. The temperature is gradually increased to 800 deg. C., when the rate is slowed down to not less than 5 deg. C. (41 deg. F.) nor more than 10 deg. C. (50 deg. F.) per minute, this rate being maintained until the end of the test, when a maximum temperature of 1500 deg. C., or 2732 deg. F., is attained.

It will be noted in the table that certain values are preceded by a plus sign (+), an asterisk (*) or both. This would not be necessary provided the cones all reached their softening temperatures at the highest temperature attained during the test; however, in a number of tests when dealing with coal ash of an especially refractory nature, there were one or more samples that did not fuse to completion. A plus sign (+) before a given value denotes that the true value lies beyond that given; an asterisk (*) placed before a given value denotes that the given value is the one actually observed during the test or the average of the observed values.

The table as prepared by the Bureau includes all the coals of West Virginia, and is therefore too voluminous for use entire in *Power*.

Because the Government Printing Office is so overloaded that it cannot print the matter in bulletin form for several months, the Bureau will not have the table for distribution until later.

TABLE OF SOFTENING-TEMPERATURES OF COAL ASH FROM WEST VIRGINIA COALS

Locality	Bed, Etc.	Softening Temperature, Deg. F. Lowest	Highest	Average	Softening Interval, Deg. F. Lowest	Highest	Average	Average Analysis of Dry Coal Percentage Ash	Sulphur
1		2	3	4	5	6	7	8	9
MONONGAHELA SERIES									
Pittsburgh Bed									
County	Town								
Braxton,	Braxton,	....	....	2090	....	....	60	8.93	3.50
Brooke,	Colliers,	2070	2600	2340	110	180	150	6.28	1.75
Marion,	Chiefton,	2040	2170	2090	30	200	100	7.41	2.97
Marshall,	Benwood,	1940	2000	1970	50	80	60	8.33	4.65
Marshall,	Moundsville,	2020	2130	2080	120	230	180	12.44	6.09
Putnam,	Black Betsey,	1930	2370	2140	70	250	130	7.39	1.94
Average Pittsburgh bed,				2170			90	7.20	2.24
Average of Mahoning bed, Conemaugh Series,		....	....	2160	....	....	130	5.62	1.89
ALLEGHENY SERIES									
Upper Freeport Bed									
Average of Lower Freeport bed,		....	....	2090	....	....	110	9.84	3.14
Average of Lower Kitanning (No. 5 Block) bed,		....	....	+2660	....	....	+140	7.64	1.76

NOTE—A plus sign (+) placed before a given value denotes that the true value is above that indicated.

An asterisk (*) placed before a given value denotes that the values given are those actually observed: however, a temperature high enough to fuse all of the samples was not attained, therefore the true value might be either greater or less than the indicated value

*Published by permission of the Director, United States Bureau of Mines.

[1]Lord, N. W., and others: "Analyses of Coals in the United States, with Descriptions of Mine and Field Samples Collected Between July 1, 1904, and June 30, 1910"; Bul. 22, Bureau of Mines, 1913, 1200 pp. (in two parts.) Fieldner, A. C., and others: "Analyses of Mine and Car Samples Collected in the Fiscal Years 1911 to 1913"; Bull. 85, Bureau of Mines, 1914, 444 pp. Fieldner, A. C., and others: "Analyses of Mine and Car Samples Collected in the Fiscal Years 1913 to 1916"; Bull. 123, Bureau of Mines. 1917, 456 pp.

[2]For detailed description of this method of discussion of the influence of various factors on the fusibility of coal ash see Fieldner, A. C., Hall A. E., and Feild, A. L.: "The Fusibility of Coal Ash"; Bull. 129, Bureau of Mines, 1918, 146 pp. (In press.)

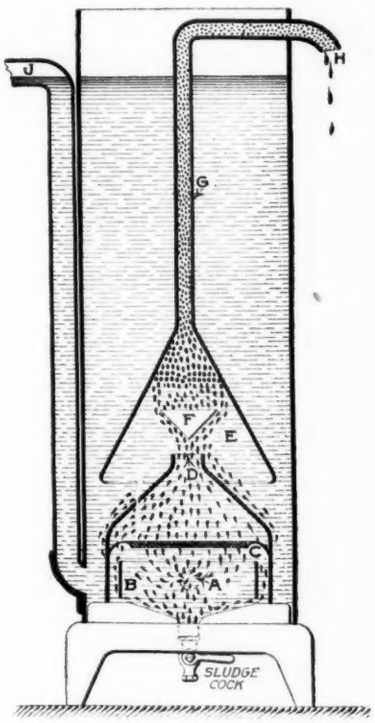
TABLE OF SOFTENING TEMPERATURES OF COAL ASH FROM WEST VIRGINIA COALS (CONCLUDED)

Locality Bed, Etc.	Softening Temperature, Deg. F. Lowest	Softening Temperature, Deg. F. Highest	Softening Temperature, Deg. F. Average	Softening Interval Deg. F Lowest	Softening Interval Deg. F Highest	Softening Interval Deg. F Average	Average Analysis of Dry Coal Percentage Ash	Sulphur
1	2	3	4	5	6	7	8	9
POTTSVILLE SERIES								
Kanawha Group								
Average Coalburg (Buffalo (Creek) bed,			+2960			80	8.80	0.76
Average of Winifrede bed,			2970			170	8.44	0.83
Average of Cedar Grove (Thacker) bed,			+2610			+160	5.83	1.07
Average No. 2 Gas (Campbell Creek, Island Creek, Upper War Eagle) bed,			+2750			+120	5.86	0.88
New River Group								
Sewell (Davy) Bed								
Fayette, Caperton,	2620	+3000	+2860	90	*360	+220	2.44	0.56
Fayette, Dun Loop,	2390	2980	2620	150	210	180	2.64	0.55
Fayette, Elverton,	2350	2650	2500	60	350	180	2.44	0.59
Fayette, Hawk's Nest,	2370	2730	2510	20	130	90	4.01	0.63
Fayette, Kay Moor,	2310	2930	2690	90	270	210	3.17	0.56
Fayette, Kay Moor	2430	2640	2530	80	140	110	3.57	0.54
Fayette, Minden,	2280	2640	2450	100	280	200	3.23	0.65
Fayette, Minden,	....	....	2600	....	....	210	2.86	0.56
Fayette, Minden,	2270	2710	2550	100	230	160	2.57	0.43
Fayette, Minden,	2080	2620	2340	30	220	110	3.13	0.88
Fayette, Minden	2370	2620	2520	50	130	100	2.43	0.45
Fayette, South Nuttall,	2580	2830	2720	30	140	70	2.62	0.57
Fayette, Sun,	2070	2550	2250	90	290	180	6.14	1.69
Greenbrier, Richwood,	....	....	2960	....	....	430	6.04	0.65
McDowell, Big Sandy,	2290	2370	2330	70	170	120	3.60	0.53
McDowell, Coalwood,	2350	2490	2420	120	230	170	2.95	0.74
McDowell, Coalwood,	2300	2650	2440	80	300	200	4.32	1.03
McDowell, Davy,	....	....	2430	....	....	90	3.48	0.54
McDowell, Davy,	....	....	2430	....	....	60	2.67	0.51
McDowell, Davy,	....	....	2460	....	....	80	3.18	0.58
McDowell, Marytown,	2520	2670	2600	80	110	100	8.95	0.75
McDowell, Roderfield,	2430	2980	2770	90	250	150	6.43	0.89
McDowell, Twin Branch,	....	....	2440	....	....	170	3.10	0.55
McDowell, Twin Branch,	....	....	3010	....	....	360	4.40	0.55
McDowell, Twin Branch,	....	....	2540	....	....	140	5.27	0.76
McDowell, Twin Branch,	....	....	2550	....	....	210	5.20	0.85
McDowell, Twin Branch,	2450	2550	2500	220	360	290	3.00	0.55
McDowell, Twin Branch,	2500	2730	2620	40	150	100	4.41	0.71
Raleigh, Cranberry,	2460	2480	2470	130	150	140	....	....
Raleigh, Oswald,	2190	2590	2380	260	270	260	4.07	0.80
Raleigh, Tamroy,	2540	+3010	+2850	*190	*190	*190	1.97	0.50
Randolph, Mill Creek,	....	....	+3010	....	....	....	11.43	0.52
Randolph, Spruce,	....	....	+2730	....	....	....	13.85	0.99
Average Sewell (Davy) bed,			+2560			+160	3.93	0.72
Average of Beckley (War Creek) bed,			+2800			+150	4.76	0.65
Average Fire Creek (Quinnimont) bed,			2540			130	6.60	0.84
Pocahontas Group								
Pocahontas No. 6 Bed								
Mercer, Simmons,	2290	2760	2400	60	190	120	2.88	0.70
Pocahontas No. 5 Bed								
McDowell, Faraday,	....	....	2350	....	....	60	3.09	0.55
McDowell, Lex,	2730	+3010	+2870	+110	+130	+120	7.80	0.65
Average Pocahontas No. 5 bed,			+2700			+100	6.23	0.62
Pocahontas No. 4 (Thin Vein Pocahontas) bed								
McDowell, Big Four,			2770			220	3.85	0.57
McDowell, Coalwood,	2100	2220	2170	50	120	70	5.29	0.67
McDowell, Coalwood,	2030	2140	2080	50	100	80	6.43	0.77
McDowell, Huger,	2190	2730	2390	60	180	100	6.04	0.63
McDowell, Vivian,	2850	+3010	+2920	60	120	+80	6.81	0.61
McDowell, Welch	+2730	+2730	+2730				7.52	0.53
McDowell, Welch,	+2730	+3010	+2900	*190	*190	*190	7.92	0.63
Average Pocahontas No. 4 (Thin Vein Pocahontas) bed,			+2480			+110	6.31	0.64
Pocahontas No. 3 (Pocahontas Thick Vein) Bed								
McDowell, Berwind,	2280	2450	2360	200	320	260	5.17	0.90
McDowell, Berwind,	2170	2340	2250	70	190	140	7.54	0.87
McDowell, Berwind,	2380	2510	2460	140	350	210	5.90	0.88
McDowell, Berwind,	2300	2340	2320	160	260	210	5.30	0.95
McDowell, Crystal,	2590	2610	2600	120	180	150	4.30	0.53
McDowell, Crystal,	2410	2520	2480	150	330	270	4.50	0.64
McDowell, Crystal,	2370	2580	2490	130	180	150	3.88	0.73
McDowell, Eckman,	2240	2500	2300	20	230	100	4.56	0.59
McDowell, Eckman,	2170	2270	2210	20	130	60	4.31	0.63
McDowell, Eckman,	2300	2380	2330	20	90	60	5.67	0.52
McDowell, Jenkinjones,	2170	2390	2240	40	220	90	4.92	0.51
McDowell, Jenkinjones,	2220	2280	2250	20	60	40	5.68	0.48
McDowell, Jenkinjones,	2120	2490	2270	20	170	110	5.62	0.53
McDowell, Jenkinjones,	....	....	2450	....	....	210	4.99	0.49
McDowell, Jenkinjones,	2190	2450	2320	40	300	140	5.16	0.59
McDowell, Newhall,	2540	3070	2810	220	290	260	4.90	0.63
McDowell, Newhall,	2520	2730	2610	110	250	190	4.27	0.63
McDowell, Newhall,	2520	2970	2690	90	320	190	4.43	0.65
Mercer, Goodwill,	2540	2710	2620	60	130	90	3.37	0.58
Pocahontas No. 3 (Pocahontas Thick Vein) Bed								
Mercer, Matoaka,	2450	2580	2820	80	300	190	3.85	0.77
Mercer, Mora,	2390	2620	2500	130	300	220	3.88	0.59
Mercer, Simmons,	2470	2540	2500	40	250	140	4.40	0.58
Mercer, Springton,	2600	3050	2740	40	170	90	3.66	0.59
Mercer, Weyanoke,	2450	3010	2690	80	340	190	4.40	0.59
Mercer, Widemouth,	2690	2890	2800	60	120	80	5.73	0.52
Average of Pocahontas No. 3 (Pocahontas Thick Vein) bed,			2440			140	4.70	0.59

New Oil Separator

A new form of oil separator has been recently patented and placed on the market by Summerscales, Ltd., of Keighley, and 4, Central-buildings, Westminster, S.W. 1, says *The Engineer*. The advantages claimed for the apparatus are that it does not consume power in its operation, requires no attention and occupies a very small space. The separator is illustrated diagrammatically in the accompanying drawing.

The object of the apparatus is to separate oil of any specific gravity from water or other liquid impurities and to cleanse it of particles of foreign bodies, such as cotton waste, etc. The mixture of oil, water, etc., is either pumped or allowed to gravitate through the inlet pipe *A*, and circulates round the guide *B*. Escaping through the annular opening at the top of the guide,



SECTION THROUGH OIL SEPARATOR

the mixture strikes the reflecting plate *C*, which throws down any heavy matter to the bottom of the separator, whence the sludge is drawn off as required. The mixture is then forced out of the inclosing chamber at *D*, and passing into the cone *E* strikes against the deflecting plate *F*. As the quantity of the mixture fed into the separator increases, the oil rises in the pipe *G* until, by reason of its specific gravity being less than that of water, it overflows at *H*. The separated water overflows at *J*.

Messrs. Summerscales state that it is quite immaterial to the action of the apparatus what the percentage of water in the oil may be, and that, in fact, it is quite applicable for the treatment of oil that is only dirty. If after the oil has passed through the apparatus, further cleansing is desired, the apparatus is somewhat modified. The oil in such case, instead of being passed at *H* into receptacles, is taken through a series of filter pads contained in the separator itself, and is finally drawn off at the bottom.

All-Around Blundering Conduct

BY J. J. JAHOBART

Joe Warner was a gas-engine operator in a large electric generating station, and having put in approximately ten years at his work, he really "knew the game." In fact, he knew some fine points that he imagined no one else about the station did, and he felt assured that there was small probability of anyone absorbing his fine operating "kinks."

New developments necessitated a change in the operating organization, and the superintendent of motive power was a man who seldom discussed his plans to any extent, but issued concise orders and demanded execution. He ordered a man added to the gas-engine crew and told Warner to break the man in as fast as possible and give him all the operating detail so that he would be capable of taking charge of a shift at the end of four weeks. The four weeks passed and an order came to the effect that the new man was to take Warner's day run, Warner was to take the night man's run and the night man was to go to work in the repair gang. This order, without any explanation from the superintendent, convinced Warner that he was being imposed on, but the demoted night man went to work in the "gang" and said nothing. Warner harbored his "grudge" for a while and at last demanded of the operating chief a reason for being put back to night work; but as the latter knew nothing about the trend of affairs, Warner went to the assistant superintendent of motive power for an explanation. This man knew all about the reorganization shift, but he also understood the methods of his superior, so Warner got very little satisfaction.

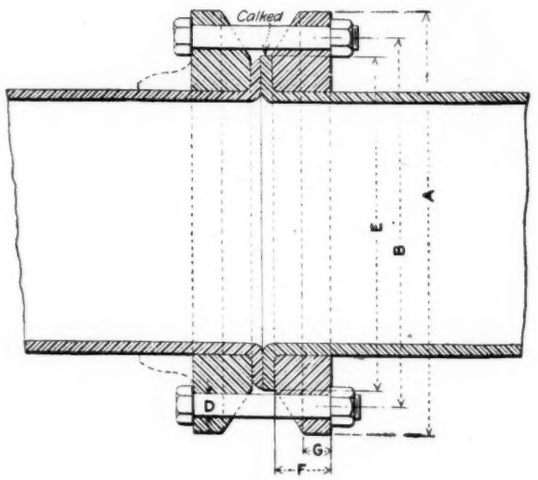
The new engineer "slaved" and "sweat blood" for he was an all-around hustler, but during the second week after taking charge he found curt notes from the superintendent's office finding fault with "operating conditions from 7 a. m. to 6 p. m." and demanding that the engineer "adapt himself more closely to detail." Then the kilowatt output of the day turn began to decrease, and the thing that really got the superintendent "up in the air" was a written protest from the chief switchboard operator relative to "excessive surging on gas-engine load from 7 a. m. to 6 p. m." and demanding that "conditions be adjusted or certain units would be cut out of service." The superintendent went into the gas-engine room and gave the new man a touch of "high life." Conditions on the night turn always seemed to be normal by 7 p. m., so the superintendent concluded that the new man needed "stirring up." But it did not get results and in the meantime Warner made written protest to the superintendent about the "abuse" the gas units were getting on the day turn. At last the superintendent ordered that the gas engines be indicated the following day and on that day there was no trouble but the next day conditions were topsy-turvy again. On the fourth day when the new man relieved Warner, he requested the turn chief to follow him on his inspection trip and picked up four wrenches of different sizes, three space gages, a hammer and a six-foot rule before starting. On this first trip they found a gas throttle partly closed, the ignition retarded 5 per cent., three gas-lift levers screwed back about one thread each, four mixing-chamber dampers about $\frac{1}{4}$ in. off their running position and one or two oil vents closed on the cylinders, all of which were quietly adjusted. There was nothing said about this state of affairs between the new man and the turn chief, but the next morning the assistant superintendent of motive power was in the station at 7 o'clock and saw the performance repeated. That day Warner was handed his discharge, a copy of which was put up in the glass-covered bulletin board and on the lower left-hand corner was a P. S.—"N. B. As a matter of personal safety, don't throw tools into moving machinery." Signed, Superintendent of Motive Power.

Warner had not, of course, thrown tools into the mechanical equipment, but he had attempted to throw a retarding element into the superintendent's organization. The latter's ultimate plan was to make the night engineer foreman of repairs. The new man was to go on night turn as soon as his tryout period was completed, and another new man was to be put on, so that Warner could be promoted to assistant master mechanic at a substantial increase in pay, but he concluded when the first change was made that he was not being fairly treated and was to be discharged.

[A kindly word or "tip" from the superintendent of motive power to Warner to "sit tight" during a temporary change, when the first order was issued, probably would have saved the man for the place and the place for the man. The superintendent surely cannot be held blameless.—Editor.]

The New Van Stone Joint

The type of Van Stone joint used now for high-pressure, superheated steam is shown herewith. The dimensions are given in the table.



DIMENSIONS OF VAN STONE JOINT, SEAMLESS DRAWN TUBING IRON-PIPE SIZE

Size of Pipe, In.	Diameter of Flange A	Diameter of Bolt Circle B	Diameter of Bolts	Diameter of Bolt Holes D	Number of Bolts	Diameter of Joints E	Thickness of Flange F	Thickness of Flange G
2	6½	5	⅝	¾	4	4⅛	1⅛	⅝
2½	7½	5⅞	⅝	¾	4	4⅝	1 1/16	1
3	8½	6⅝	⅝	¾	8	5⅝	1 3/16	1
3½	9	7½	⅝	¾	8	6¼	1 5/16	1⅛
4	10	7⅞	⅝	¾	8	6¾	1 5/16	1⅛
4½	10½	8⅜	⅝	¾	8	7⅜	1 7/16	1⅛
5	11	9⅛	⅝	¾	8	8¼	1 7/16	1⅛
6	12½	10⅝	⅝	¾	12	9	2	1⅛
7	14	11¾	⅝	¾	12	10	2 1/16	1 3/16
8	15	13	⅝	¾	12	11	2 1/16	1 3/16
9	16½	14	⅞	1	12	12¼	2⅛	1 5/16
10	17½	15¼	1	1⅛	16	13⅜	2⅛	1 5/16
12	20½	17¾	1⅛	1¼	16	15⅝	2 3/16	1 7/16
14	O.D. 23	20¼	1⅛	1¼	16	17	2 5/16	1 7/16
15	O.D. 24½	21⅝	1¼	1⅜	20	18	2 5/16	1 7/16
16	O.D. 25½	22⅝	1¼	1⅜	20	19	3 5/16	2⅛
18	O.D. 28	24¾	1¼	1⅜	24	22	3 5/16	2⅛

EDITORIALS

Waste of Fuel Oil

FUEL sufficient to operate the railroads of the United States for one month is being wasted every year by the users of fuel oil. Five times the fuel necessary for all the Federal Government, including its Navy and Army, is being thrown away by these same users of fuel oil. The fuel being squandered, and recklessly too, by these same fuel-oil users is approximately equivalent to the entire output of coal for the State of Colorado in one year's time.

These are the startling conclusions that have been drawn by experts of the Bureau of Mines, Department of the Interior, who have been coöperating with the Fuel Administration in a general survey of the use of fuel oil for power purposes in the United States. They find that last year one hundred and sixty million barrels of fuel oil was used and that forty million barrels, or one-fourth of the amount, was wasted and might have been saved by more intelligent operation of plants and proper firing. This represents a useless expenditure of one hundred and forty million dollars a year, or enough money to pay some of the country's important war bills, the fuel oil selling at about three dollars and fifty cents a barrel. The experts also say that this wastage is doubly criminal at this time because of the urgent need of fuel oil for the ships of the Navy and for other essential war purposes. Further, they declare that the forty million barrels of fuel oil lost each year is the equivalent of ten million tons of coal.

We do not question the Bureau's figures; they are the result of searching inquiry. The situation is therefore astonishing. One would think that after more than two years of fuel shortage, after more than a year and a half of war, of our active participation in it, that waste of so precious a commodity as fuel oil would be at a minimum instead of such woeful magnitude. Power plants are likely responsible for comparatively little of this waste. The loss occurs for the most part, we believe, in the petroleum industry itself and in the industrial application of oil. The Fuel Administration and the Bureau will find the leaks, however, for engineers of both are now closely inspecting the sections which consume heavily of fuel oil. They will visit power plants.

Buy Bonds Despite German Peace Note

GERMANY, in submitting her note proposing a peace parley with the Allies on the basis of President Wilson's principles, means but one thing. She desires a breathing spell from the distressing punching that Marshal Foch has been administering continually since last July. If arrangements could be made whereby hostilities could be discontinued for a few weeks while representatives of the Kaiser and those of the Allies were sitting around a table discussing peace terms, a situation would be made to the German's liking, but it would merely prolong the day when Germany will admit defeat. That time has not yet arrived. Germany in her peace note only admits that she is checked for the time being. She is not yet defeated. She is sparring for an opening, and if she can cause the hammering of her lines to cease, it will give her a chance to reconstruct those units that have been disorganized by the thousands of killed, wounded and prisoners.

What reply President Wilson will ultimately make to the proposal is unknown, but the official answer to the peace notes of the Central Powers may be safely entrusted to our Government.

There is another phase of this proposed peace overture. Nothing would be more satisfactory to Germany than to know that the Fourth Liberty Loan of $6,000,000,000 was a failure. Did the Central Powers time their peace note with a view of creating the impression in this country that they were ready to lay down their arms? We hazard a prediction that this point was not overlooked. Germany knows full well the tremendous weight and the significance of the popular support of the war by the people who are as one in backing up the President, the Army and the Navy. It would be glorious news to Germany to learn that because of this peace note the American people had been lulled into a feeling that the war is practically over and that there is no need to carry out the $6,000,000,000 loan to a successful conclusion.

Safeguarding Against Shutdowns

THE uncertainty and irregularity of coal deliveries, brought about by the abnormal strain put upon the transportation systems of the country, have served to focus the attention of power-plant owners and engineers on the problem of storing coal. In the days previous to the war the average steam-power plant was operated in a sort of hand-to-mouth fashion, so far as fuel was concerned. The quantity on hand at any given moment was only sufficient for a few days or weeks, because it was possible to rely on the arrival of fresh shipments before the bottom of the bin was swept clean.

Like a great many other things, that easy-going practice will have to be abandoned to a great extent. At the present time the most important duty of power-plant operators is to keep the wheels turning continuously. The necessity of keeping up the steady flow of military supplies and munitions makes it imperative that every source of power be maintained in a condition of maximum productivity.

The storage of coal, therefore, passes out of the state of being merely desirable and takes on the aspect of being highly necessary. It forms a guaranty against the failure of fuel supply except under the most extraordinary circumstances. But its value extends farther. It spreads the demand for fuel over a greater part of the year and so keeps the miners at work more regularly. In addition, it enables the railroads to effect the deliv-

eries under the most favorable weather conditions and with the most advantageous use of their cars and locomotives.

Of course, storage of coal means new problems for the engineer and added expense for the plant owner. But the published data concerning the methods of storage and the precautions to be observed to prevent spontaneous combustion should go far toward smoothing the path for the engineer. On the other hand, the owner may console himself with the thought that the cost of the storage pit and the coal-handling apparatus is a mere trifle as compared with the loss he would sustain if his plant were compelled to suspend operations for extended periods or be dependent on infrequent and irregular deliveries of fuel. He may discover that a storage equipment is a cheap form of insurance against shutdowns.

The Emergency Power Act

THE provisions of the Emergency Power Act, an abstract of which is given on page 579 of this issue, are sweeping in their extent and confer vast power upon the President. Only the danger of a shortage of power, with consequent hindrance and delay in the manufacture of materials and products vitally necessary to the maintenance of the country's great part in the war, could have brought about legislation of this kind.

For the period of the war—by which is meant the time to elapse until six months after the proclamation by the President of the exchange of ratifications of the treaty of peace—the President is authorized and empowered to provide sufficient power for war work by taking control of existing plants or adding to their capacity, by building new plants, by consolidating power systems, or by diverting power from one industry to another that he may deem more important to the national welfare.

Under the usual interpretation, a power plant would be considered as any plant producing, distributing or transmitting mechanical or electrical power; but under the provisions of the Act this term is taken to include also the products made through or in connection with the coking of coal or lignite or by combustion. The Act would thus place at the disposal of the President a vast amount of property, machinery, appliances and transmission lines, sufficient to insure an ample supply of power for the industries on which the security and defense of the country depend.

Liberate Austria's Slaves

AUSTRIA-HUNGARY! A ramshackle empire from the first, founded on an unholy alliance between South Germans—the Austrians—and the Magyars, who are half Turk, its cornerstone blood, its policy greed, its method lying and trickery, it now is falling, and to save itself wants peace. But even in its extremity it refuses to be honest either with itself or with the world. Like a murderer (which the Hapsburg is) going to the chair, the emperor shouts his lie about innocence and puts on a braggadocian front while his knees sink beneath him. And now comes the blustering insolence of the "peace bid" of September Fifteenth. Having been squarely met by President Wilson and repudiated for what it was—the Hapsburg bluff—Austria-Hungary now opens up with a gun of another kind.

Having enslaved for centuries the Czechs (we are better acquainted with them under the name of Bohemians), having enslaved the Slovaks, the Slovenes, the Croats and the Poles, Austria-Hungary now intimates that the great gift of autonomy, of self-rule, is to be conferred upon them. But there is a string—these peoples (to-be-self-ruling) must never rule themselves in any way not agreeable to Austria-Hungary! After all, it would be intensely comic were it not all so tragic. If we could be deaf to the cries of the dying, we should break into roars of sardonic laughter. But as it is there is but one thing to do—talk to Austria and Hungary and Germany in the one language they understand, the language of the guns.

And the more shots we can fire the sooner will the talk be finished, with the Central powers making the one offer which will be accepted—repentance, reparation and reform.

Liberty Bonds load guns. When an American writes his name at the bottom of a Bond subscription blank, he is sending an ultimatum to Austria-Hungary; he is writing a line into the Declaration of Independence for the Hapsburg slaves. Buy Bonds!

Conserving Heat Outside the Boiler Room

HE DOES well who prevents all avoidable waste of coal in the boiler room; but the job is only half done if waste occurs after the steam starts on its way to the various points of consumption. It does not take long for heat equivalent to a ton of coal to radiate away into the atmosphere, leak out through sandholes and untight joints, or slip silently away to the sewer unseen. Why, a trifle more than twenty-five square feet of bare pipe wastes more than a ton of coal a month at customary boiler pressures.

With the coal conservation committees now forming in all manufacturing and other plants, losses of heat beyond the power plant, of considerable magnitude in most places, will be minimized. It is well, too, to have in mind that the more it costs to produce the heat and get it to the points where waste occurs, the more serious are leaks of a given size or weight.

The consummate skill with which President Wilson is handling the present situation suggests that in his youthful days he may have had success in trapping that well-known odoriferous member of the *Mephitinae* family—the skunk.

The steam-engine indicator, the Orsat, draft gage and the thermometer are the small arms of the industrial army. Are you armed and are you fighting?

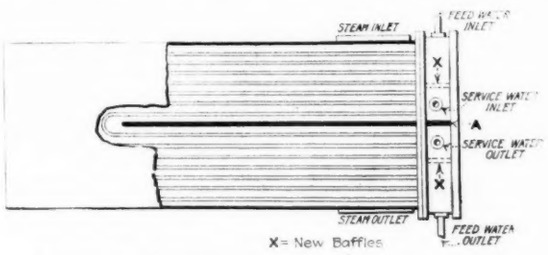
"A drop of petroleum is equal to a drop of blood," says a French senator. Think of this when you use it or its distillates as fuel or lubricant.

Firemen, you know the Star Spangled Banner. Whistle it while you shovel that precious coal.

CORRESPONDENCE

Heater Arranged for Two Water Services

The illustration shows how a feed-water heater was arranged to supply a separate hot-water service for two different purposes. The space at the end of the heater, between the head and tube sheet, was fitted with a 1-in. oak baffle on each side of the original baffle, as shown



BAFFLES DIVIDE HEATER INTO TWO PARTS

by the dotted lines. Openings were drilled and tapped into the side of the heater for the new service water-pipe connections. Since the heater has ample capacity for both the boiler-feed water and other service, there is no difficulty in maintaining the desired temperature.

Philadelphia, Penn. M. A. SALLER.

Troubles from Inefficient Help

The master mechanic, after listening to considerable talk about inefficient men, related an instance that occurred after he had taken charge of a coal mine in ——.

"Everything was on the blink proper, and I was putting in some long shifts at the machine shop, and did not have time to go around and size up the works or plant. I had been on the job about four days when I was called to the power house and found that the babbitt in the crosshead of the big engine had melted. The engineer was an uneducated Slav, and about all the satisfaction one could get out of him was 'no savvy' or a shrug of the shoulders. I had to remove the crosshead and rebabbitt it.

"At the same time I noticed a heavy gummy substance all over everything about the engine, and upon closer examination of the engine and the oil barrels standing around, I found that the engineer had just finished using a barrel of linseed oil, not knowing the difference between it and engine oil. Then it was only a couple more days and the crankpin brasses melted out and this kind of trouble continued until everything about the engine had been overhauled. This trouble was all due to the linseed oil gumming up the oilways.

"I soon found that the engine used more steam than necessary and it had a horrible rattle. The cylinder head was removed and it was discovered that the piston was worn badly and that the rings were in pieces. Upon investigating the kind of oil being used in the lubricator it was found that the engineer had run out of cylinder oil just a few days before the trouble and had used five gallons of lard oil in the cylinders. It was necessary to keep this man on the job until an engineer who had been sent for arrived.

"A few more days passed in peace, when one morning word was received that the engineer was having trouble with the generator. Investigation disclosed that the commutator was badly burnt, also the brush holders, and the main switch on the switchboard was practically melted. The cause was a large file welded across the two top contacts of the main switch. The engineer had laid this file across the switch contacts and then had thrown the switch in, causing a dead-short-circuit on the generator, with no circuit-breaker or fuses for protection.

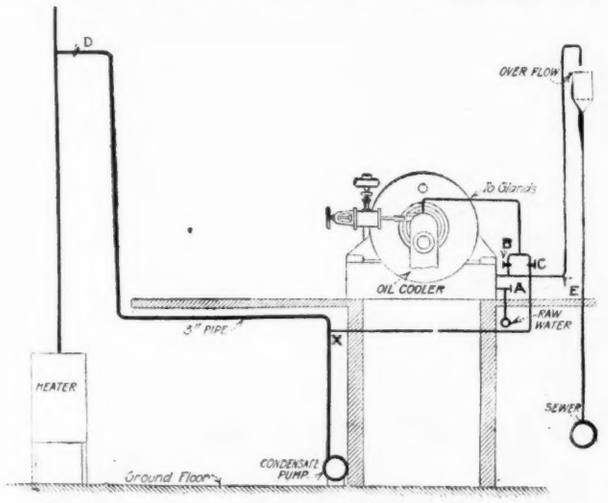
"The engineer was discharged at once, and the master mechanic ran the plant until the new man arrived. This is just one example of what mine operators sometimes experience from inefficient help."

Lafayette, Colo. FRANK HUSKINSON.

Sealing Water for Turbine Glands

In some plants a special still for softening water for sealing the turbine glands is used, but we have the water from the condensate pump piped to the glands and this arrangement has been operating for 2½ years giving no trouble whatever. The piping is shown diagrammatically in the illustration.

Raw water enters the oil-cooling coils in the base of the turbine bedplate through valve *A*, discharges into



CONDENSATE USED IN SEALING TURBINE GLANDS

standpipe *E* and overflows into a funnel about 14 ft. above the turbine-room floor. From the funnel the water goes to the sewer. The elevated discharge is to obtain the desired head. The discharge pipe from the condensate pump (at the left) rises to about the same level as the overflow of the standpipe and discharges down to the feed-water heater through the vent pipe which, being open, prevents siphoning. A check valve is placed

at *D* to prevent steam from the heater coming back when the turbine is shut down. A ¾-in. pipe is tapped into the riser or discharge of the condensate pump at *X*, running to the turbine glands into which is also connected a ¾-in. pipe from the raw-water pipe. When starting the turbine raw water is used, through valve *B*, but after the load is on so there is enough condensate, valve *C* is opened so that the condensate flows to the glands and valve *B* is closed. W. M. WILSON.

Fenton, Mich.

An Emergency Attachment Plug

One day I needed an attachment plug for an extension cord but could not find one, so I took a plug fuse that had been blown and a short piece of drop cord, cut one wire about ¾ in. shorter than the other, then soldered one wire (the long one) to the center of the plug on the inside and the other wire to the side. I then filled the plug with plaster of paris, putting the brass cap and mica top back on the plug, first cutting a hole in the mica for the cord to go through and let the plug dry in a warm place over night.

In the morning I connected it to an extension cord and found it to be as good as an ordinary attachment plug. WALTER E. ROBINSON.

Amherst, Mass.

A Small Plant Saves Much Coal

In our plant we have four 150-hp. return tubular boilers, and had until recently been firing three of them, forcing them considerably to furnish the required steam. The boilers are set in a row and inclosed in a battery setting. One of them has never burned its coal as well as the others and therefore it loafed along on the line. Attempts to get it to steam as well as the others were futile, although it is of the same size and capacity. Different grates were tried, a new type of bridge-wall was used and other minor changes were made; but these did not enable the boiler to do its full share of work.

We had considerable tube trouble with all the boilers and engaged a man to weld new ends on most of the tubes. It was while this job was being done that I found the cause of the trouble. On getting up on the boiler from the back end when the back plate was off, I noticed that the distance from the back head to the back wall was too great by the width of at least one brick. A course of brick one brick wide was laid against the back wall from the bottom of the combustion chamber to the top where the back plate rested. This caused a desirable change in draft, and immediately gas analyses from this boiler showed 11 to 14 per cent. CO_2, whereas 6 per cent. was about the highest we ever got before. After this all the settings were coated with one-quarter inch of cement for the purpose of cutting down on the air infiltration through the brickwork. An automatic damper regulator was installed. These few and simple changes enable us to get an average of 11 to 14 per cent. CO_2 for each day's run, to operate now with two boilers instead of three, and to make work in the boiler room much easier. I now want some good means of blowing the boiler tubes frequently, say every two or three hours, and I believe that this, together with what we have already done, will result in a saving of about $3000 a year for coal. This estimate liberally allows for the interest and overhead on the investment which will effect this saving. JAMES T. MACKAN.

Columbus, Ohio.

Diagnose These Indicator Diagrams

The accompanying two cards taken from the high-pressure cylinder of an 18 and 42 x 42-in. Nordberg cross-compound Corliss engine, are offered by the writer as a mental stimulus for some of the indicator experts, from whom a diagnosis as to the cause of the trouble and what was done to remedy it is requested. Card No. 1 shows the condition at the time the behavior of

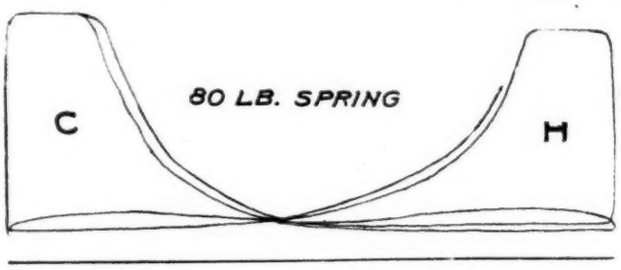


FIG. 1

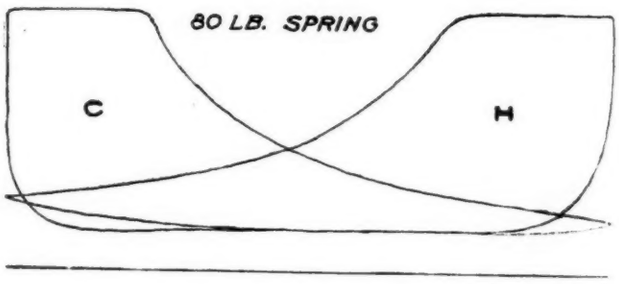


FIG. 2

FIGS. 1 AND 2. INDICATOR DIAGRAMS FOR DISCUSSION
Fig. 1—Diagrams from high-pressure cylinder before alterations. Fig. 2—Diagrams from high-pressure cylinder after making repairs.

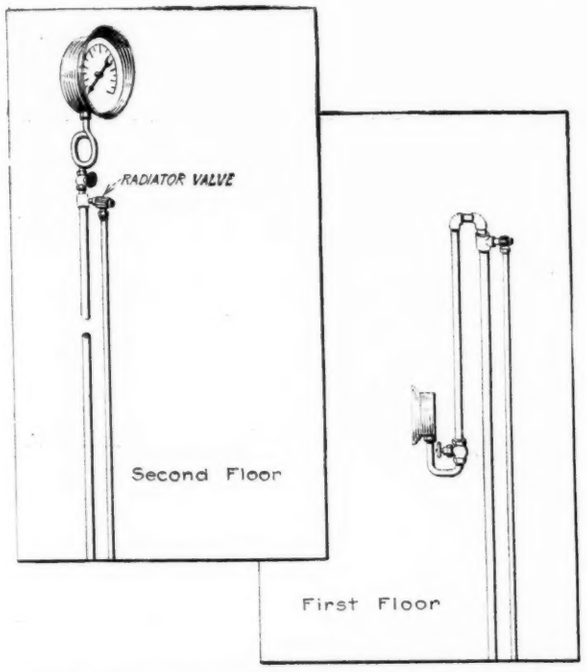
the engine indicated that something had happened. The steam pressure was 140 lb., the receiver pressure 14 lb. and the speed 100 r.p.m. An 80-lb. spring was used. Data for card No. 2 are the same, with the exception that the receiver pressure was 16 pounds.

Omaha, Neb. R. N. ROBERTSON.

Wrong Pressure-Gage Connections

The manager of an office building had a steam-pressure gage placed in his office two floors (about 35 ft.) above the boilers, and at the start it registered the same as the gage in the boiler room, but there was a small escape from one of the threads near the gage which allowed the entrapped air to escape and the pipe to fill with water, and the new gage would register considerably lower pressure than the one on the boiler. A steamfitter was called in and connected a radiator air valve just below the gage and a ¼-in. pipe drip running to the boiler room, as shown. This kept the line free from water and the gages read right.

Some years later the manager moved his office to the floor below and had the location of the office gage changed without altering the piping except by connecting a 20-ft. drop, as shown at the right in the illustration. In its new location the gage of course showed too high a pressure. The steamfitter was again called



DIFFICULTY WITH PRESSURE-GAGE CONNECTIONS

in, shortened the main and bleeder pipes, lowered the tee and valve to the room below, making the connection as before so that the gage could again register the pressure correctly.

JAMES E. NOBLE.

Portsmouth, Ont., Canada.

[Removing the water seal that must have existed somewhere in the original piping would have been the logical thing to do instead of connecting in the extra bleeder.—Editor.]

Different Water Level

On taking over a large steam plant that contained several water-tube boilers of the double-drum type, I found that on one boiler the gage-glass on one drum showed a different water level from that on the other. I remarked this to the retiring engineer, who answered that it had always been so.

At the first opportunity I opened up the boiler and did not find any apparent reason for the difference in water levels until I came to clean the rear vertical tubes with the tube cleaner, when I was surprised to find that the tubes from one drum were practically clean and those from the other drum were nearly filled with scale. After cleaning and closing up the boiler the water levels were equal.

I reasoned that the drum with the clean tubes was doing the greater part of the circulation and consequently showed a lower level of water than the other drum in which circulation was retarded. From this and other experience I have found that it pays to be particular in keeping the tubes clean. The saving in fuel and the easier steaming far more than offset the labor and expense, and the cleaning also prevents the burning out of tubes.

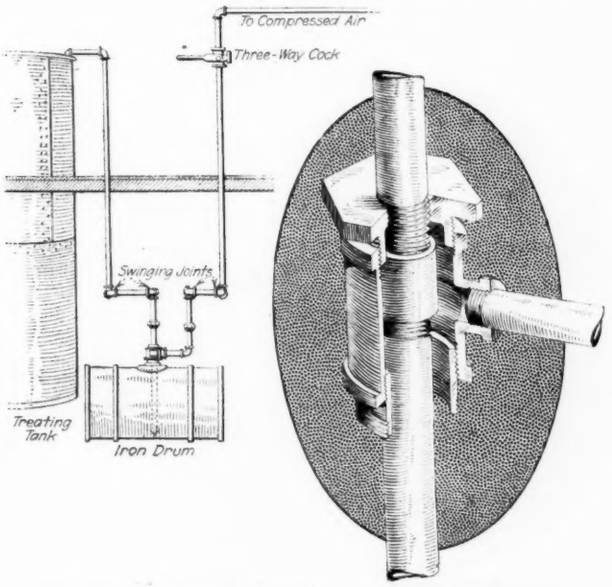
R. D. SMITH.

Three Rivers, Quebec.

Air Blowing Outfit

In the manufacture of one of the products of a plant where I was employed a year or so ago it was necessary to treat a certain liquid with sulphuric acid, which came in iron drums holding about 1500 lb. each. The drums had one outlet which was tapped for a 2-in. pipe. Later, drums were received with a different thread, for which I made a bushing so as to use the same blowing outfit that I had previously made. Formerly, the men poured the acid into 5-gal. cans, in which it was carried upstairs and poured into a tank. The blowing outfit is readily understood by referring to the accompanying sketch.

By operating the three-way cock to apply the pressure on the drum, a quick and easy way of shutting off the flow of acid is provided. The open outlet of the cock acts as a discharge for the pressure in the drum, so that



PIPING AND DETAILS OF PIPING AND AIR HEAD

as soon as the air supply to the drum is cut off, the discharge is opened. At the unions are two swinging joints on each line, which make it easy to connect up a drum.

C. R. ALEXANDER.

Oklahoma City, Okla.

Wiping Commutators

I cannot say that I agree with Mr. Purcell's manner of wiping commutators, as shown on page 172 of the July 30 issue of *Power*. It seems to me that vaseline fed in the manner described would flow too freely, especially in the summer time when vaseline becomes quite soft.

Although there have been numberless contrivances made for lubricating commutators, there seems to be nothing better than a good carbon brush and a very little vaseline or good oil applied occasionally on a good grade of muslin rag.

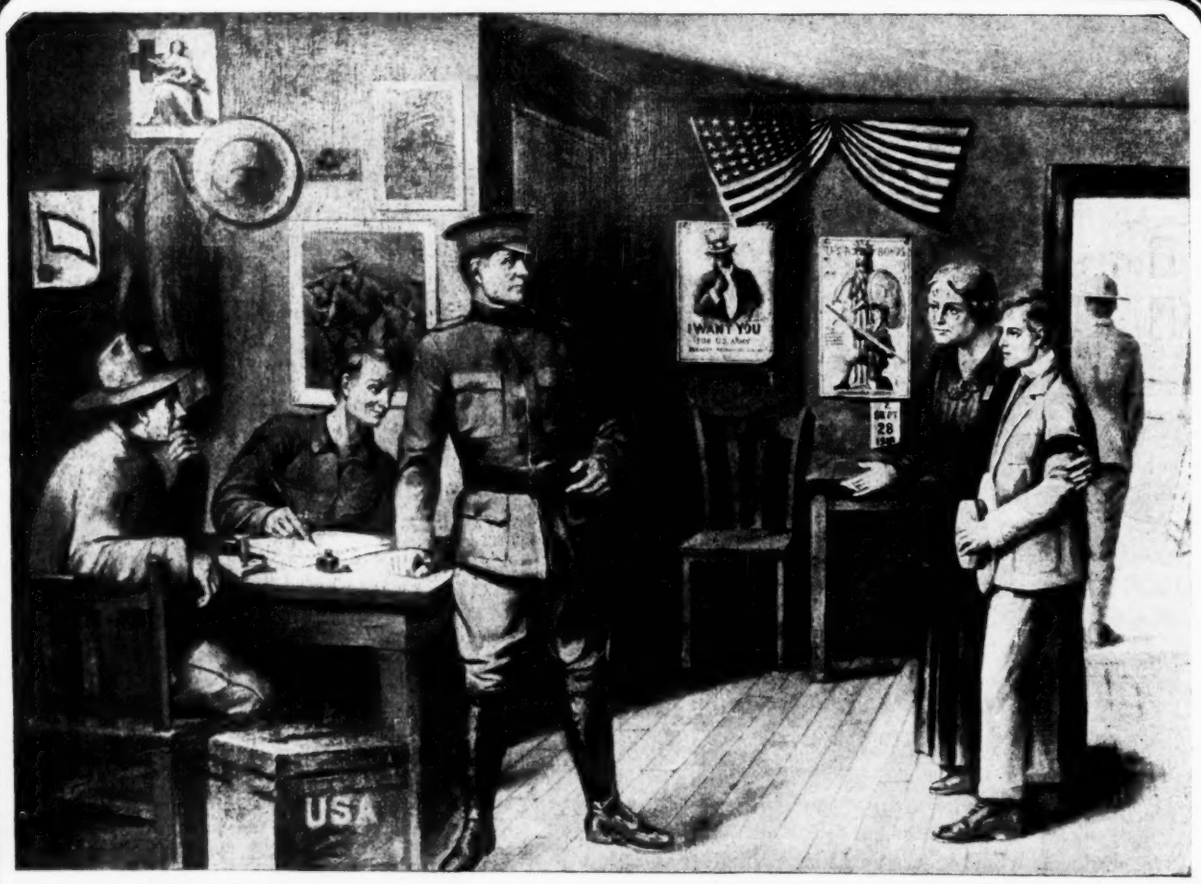
There are graphite brushes made today for practically all grades and types of commutators, and these are almost self-lubricating. For additional lubrication take about as much oil as adheres to a finger after being dipped into a quantity of it, rub on a rag and use this for wiping; if the commutator and brushes are in good condition no trouble should result. This is the method we use and prettier commutators than ours cannot be found in a day's travel.

Another mistake often made is in wiping a commutator and then letting it go a couple of hours before again touching it; then slapping on a lot of oil and wiping again in an hour or so. This is bad practice. The wiping of commutators is somewhat like the firing of boilers—"little and often" gives the best efficiency.

Norristown, Penn. WILLIAM H. WATSON.

The Fuel Administration estimates that the total saving of coal as the result of the daylight-saving plan will amount to 1,250,000 tons.

THE SUPREME SACRIFICE



From Painting By FRANK J. VALENTI

There's a little woman in our town
Who can't give a penny away.
Her savings have all but vanished—
E'en those for "the rainy day."
She'll hear all the Fourth Loan cheering
And pray that it means success;
But she hasn't bought any bonds before
And each day her store grows less.

She hasn't a War Stamp button
And she's minus a Red Cross tag.
The pin that the little woman wears
Is a three-starred service flag.
The three-starred field of her emblem
Marks a sacrifice untold,
For two blue stars protect a third—
And that one is of gold.
Yes, this little woman in our town

Who can't give a penny away
Gave three brave sons and offers the fourth
On Fourth Loan Liberty Day!
Would you cheer the heart of this mother
Who has given HER ALL to the fray?
Then buy and buy and buy and buy
Fourth Liberty Bonds today!

From New York Herald

INQUIRIES OF GENERAL INTEREST

Definition of Load Factor—What is meant by the load factor of a power plant? F. T.

The load factor is the ratio of the average power to the maximum power during a certain period of time. The average power is taken over a certain period of time such as a day, month or year, and the maximum is taken over a short though actual interval of the maximum load within that period. In each case both should be specified.

Regulation of Damper Opening—In regulation of dampers for variable requirements of draft to maintain uniformity of steam pressure, is it better to swing the damper to extreme open or closed positions or to change the damper opening gradually? R. S.

With the damper wide open the percentage of CO_2 falls, owing to excess of air, and with the damper closed CO forms, owing to lack of air. Although the steam pressure may be maintained more uniformly by changing the damper from one extreme position to the other, more economical combustion is to be obtained by gradual changes of damper opening.

Cylinder Clearance of Direct-Acting Steam Pump—Why are the steam cylinders of direct-acting steam pumps made with so much greater percentage of clearance than the cylinders of ordinary steam engines? L. J.

It would be dangerous to run a direct-acting steam pump the fullest length of stroke or allow the piston to travel close to the head, for a slight change in conditions of steam pressure, pump friction or pressure pumped against might cause the piston to strike the head. Hence ample piston-travel clearance must be provided, as the amount that will be obtained cannot be fixed as in a steam engine and there is accordingly a larger percentage of clearance volume.

Grooving of Boilers—What is grooving of a boiler and by what is it caused? M. T.

Grooving is the corrosive action which is aggravated by local movements of the material caused by changes in pressure or temperature. These slight movements, which are like a hinging action at corners and at joints and laps, loosen particles of rust as fast as they are formed, thus exposing a fresh surface for formation of more rust, and the corrosion from this cause is continually extended deeper in the form of channels or grooves. Such local corrosion is commonly found to have occurred in the flanges of heads, and at the bottom of a water-leg where it is joined to a solid mud ring, and very frequently along the side seams of boilers which have lap joints running the length of the boiler, and in small vertical boilers. Grooving along a lap seam is undoubtedly due to the bending that occurs when a lap seam is under pressure, for such grooves are not found where double strap-butt joints are used for the longitudinal seams.

Derivation of a Safety-Valve Formula—What is the derivation of the formula $A = \frac{W \times 70}{P} \times 11$, for the area of a spring-loaded safety valve, where A is the area of valve in square inches per square foot of grate surface, W the weight of water, in pounds, evaporated per square foot of grate surface per second, and P the pressure (absolute) at which the safety valve is set to blow? C. H. R.

The formula is based on Napier's approximate formula,

$$W = \frac{a \times P}{70}, \text{ or } a = \frac{W \times 70}{P}$$

for the approximate weight W in pounds of steam discharged per second through an aperture whose area in square inches is a and absolute pressure is P, when discharge takes place against a pressure that is less than 58 per cent. of the initial pressure.

The rise of a spring-loaded safety valve is assumed to be $\frac{1}{31}$ of the diameter of the valve, and the effective cross-sectional area of the discharge aperture, whether the valve seat is 45 deg. or 90 deg. with the axis, is assumed to be equivalent to 0.7 of the cylindrical area due to the rise. Hence calling d = diameter of the valve, the effective area of the discharge aperture is

$$\frac{d}{31} \times d \times 3.1416 \times 0.7 = \frac{2.19912}{31} d^2$$

and as A, the full area of the valve, is equal to $d \times d \times 0.7854$, the effective area of the discharge aperture is only

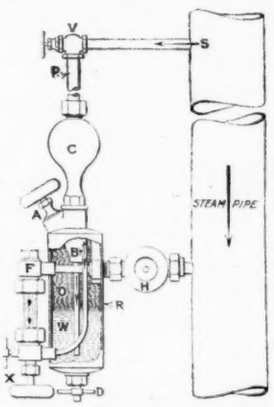
$$\frac{\frac{d}{31} \times d \times 3.1416}{d^2\ 0.7854} \text{ or } \frac{1}{11} \text{ of } A.$$

Hence when A in the safety-valve formula is taken as the area of the valve, the effective area of aperture a per the Napier formula becomes $\frac{A}{11}$ and the Napier formula becomes

$$\frac{A}{11} = \frac{W \times 70}{P} \text{ or } A = \frac{W \times 70}{P} \times 11.$$

Operation of Double-Connected Cylinder Lubricator—How does a sight-feed cylinder lubricator operate to discharge the cylinder oil into the steam pipe against the pressure of the steam? A. L. R.

The motive force of an ordinary double-connected cylinder lubricator is the hydrostatic pressure of a column of water that is maintained by condensation of steam admitted through the upper connection of the lubricator with the steam supply pipe of the engine. Referring to the sketch, steam admitted at S through the valve V is condensed in the condenser pipe P and condensing chamber C, which is connected by a pipe with an open end extended nearly to the bottom of the reservoir R. Before valves H or V are opened, the reservoir is filled with oil by removal of the plug A. Then with A returned to its place, when the valve V is opened, condensate formed in the pipe P and chamber C becomes a column of water from the valve V to the bottom of R. The pipe P should be about 2 ft. long, so the pressure above the reservoir due to the column of water will be about 1 lb. per sq.in. Upon opening the valve H the sight-feed glass becomes filled with water formed by condensation of steam entering by the lower connection. Any oil O contained in the reservoir, being lighter than water, remains in the upper part of the reservoir R. Upward pressure exerted by the water W due to the head of water that has accumulated by condensation of steam entering at S, plus the pressure of the steam, forces the oil from the upper part of the reservoir down through the open end of the bent pipe B to the needle valve X, by which the flow of oil can be regulated in its passage up through the sight-feed glass and from which it passes from F across to the lower connection at H to mix with the steam going to the engine cylinder. A glass gage on one side of R, not shown in the sketch, indicates the amount of oil in the reservoir



[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

How To Burn Coal at Home

THE present large interest in the saving of coal in order that the war industries may have an ample supply has caused the Bureau of Mines, Department of the Interior, to issue Technical Paper 139, "Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces," by Henry Kreisinger, C. E. Augustine and S. H. Katz.

The paper presents the results of a study of the processes of combustion in the fuel bed of hand-fired furnaces when burning coal at such low rates of combustion as are used in house-heating apparatus. The study is an extension of the work reported in Technical Paper 137, which covers the higher rates of combustion, such as are used in burning coal under power-plant and locomotive boilers. The same apparatus and largely the same methods were used as in making the experiments with high rates of combustion.

The tests were divided into three groups according to the method of charging the fuel and of feeding the air under the grate.

In the tests of the first group air was fed under the grate at a uniform rate, and the fuel was charged in small quantities at short intervals as is done in firing coal under power-plant boilers. The object of charging the fuel in this way was to make tests at low rates of combustion comparable with those made at high rates and reported in Technical Paper 137. The rates of combustion used in these tests were 10, 6, and 3 lb. of fuel per square foot of grate per hour. Two nearly constant thicknesses of fuel bed, 6 and 12 in., were used for each rate of combustion. The fuels used were Pittsburgh coal, anthracite, metallurgical coke, and semicoke.

The tests of the second group were made under similar conditions as regards feeding of air, but the fuel was charged in large quantities at long intervals to simulate the feeding of coal in house-heating apparatus. On account of the large charges the thickness of the fuel bed could not be kept constant, but varied from 12 to 6 in. The tests were made at rates of combustion of 10, 6, and 3 lb. of fuel per hour, and with Pittsburgh coal only. Special attention was given to the distillation of volatile matter, and the changes in the condition of the fuel bed during the long firing cycles.

In the tests of the third group all access of air through the grate was completely shut off, the object being to determine whether the fire can be kept burning for any length of time when the ashpit is tightly closed and under what conditions the fire could be kept over night when using different kinds of fuels. These tests were made with Pittsburgh coal, anthracite and coke, and with fuel beds 12 and 18 in. thick.

The Fuel Bed of a Hand-Fired Furnace Acts as Gas Producer and Retort

The fuel bed of a hand-fired furnace acts principally as a gas producer and gas retort; that is, the processes taking place in the fuel bed consist mainly of the gasification of the solid fuel. The oxygen flowing up through the grate is all used as it passes through the first three or four inches of the fuel bed. The products of combustion in this part of the fuel bed are largely CO_2, and a smaller percentage of CO. At a height of three to four inches from the grate the CO_2 content of the gases reaches a maximum of 12 to 18 per cent. As the CO_2 passes through the upper layers of the fuel bed, it is reduced by contact with the hot coal to CO, which, with the combustible gases distilled near the surface of the fuel bed, constitutes 16 to 30 per cent. of the gases rising from the fuel bed.

The ratio of the weight of air that can be supplied through grate to a pound of coal gasified remains constant at about 7 to 1. This ratio holds over a very wide range of rate of gasification. The faster the air is supplied the faster the fuel gasifies, the combustible content of the gases at the surface of the fuel bed remaining nearly constant. Therefore the amount of air supplied through the grate determines only the rate of combustion and not its degree of completeness. The rate of combustion in house-heating apparatus can be regulated only by control of the supply of air through the grate, which is done largely by manipulating the damper in the ashpit door.

For the complete combustion of one pound of average coal about 14 lb. of air is necessary; however, as only 7 lb. of air per pound of coal can be supplied through the grate, another 7 lb. must be supplied over the fuel bed in order that the gases rising from the fuel bed may be completely burned. As, roughly, one-half of the combustion process takes place in the fuel bed and one-half in the combustion space, the addition of air above the fuel bed for completely burning the gases and preventing smoke is essential. This additional air should be introduced close to the surface of the burning fuel and, if possible, in many fine streams to facilitate its mixing with the combustible rising from the fuel bed.

The process of combustion in the fuel bed is essentially the same whether firing is in small quantities at short intervals or in large quantities at long intervals. During the distillation period the percentage of combustible in the gases rising from the fuel bed is larger than it is after the volatile matter has all distilled, because during this period the fuel bed acts both as a gas producer and as a gas retort, whereas after distillation has ceased the fuel bed acts only as a gas producer. Therefore, while distillation is going on more air must be supplied over the fuel bed to burn the gases completely than after distillation has ceased. This requirement for a variable air supply over the fuel bed makes smokeless and economic burning of soft coal in hand-fired furnaces difficult. At low rates of combustion a large part of the combustible rising from the fuel bed is in the form of tar and soot, which are difficult to burn because they require a greater concentration of oxygen than is usually found in the furnace gases.

Difficult to Keep Fire Going Overnight with Air Supply Shut Off

When the air supply through the grate is completely shut off it is very difficult to keep the fire going overnight, particularly when burning anthracite or coke. When it is desired to keep fire with these fuels overnight, the fuel bed should be built up to at least 12 in. and a small amount of air must be admitted through the grate. With the commercial house-heating apparatus enough air to keep the fire going may leak into the ashpit when the ashpit door is closed. Enough air to maintain combustion will not enter the fuel bed from the top surface.

As the gases rising from the fuel bed contain a large percentage of carbon monoxide (CO) it is not advisable with hot-air furnaces to close entirely the damper in the smoke pipe, if there is one, because the poisonous carbon monoxide may escape through defective joints into the air jacket and enter the rooms.

Economic combustion of coal centers in proper air supply. The two fundamental principles of air supply in hand-fired furnaces are:

1. The amount of air supplied through the grate determines the rate of combustion; that is, the amount of coal that can be burned depends directly on the amount of air that is supplied through the grate. If one wishes to burn the coal faster he must supply proportionately more air through the grate. In like manner, if one wishes to burn less coal he must supply proportionately less air through the grate.

2. The completeness of combustion is determined by the amount of air that is supplied over the fuel bed per each pound of coal burned. If five to seven pounds of air is supplied over the fire per each pound of coal burned, the combustion should be nearly complete; if it is not complete, it is not due to insufficient air supply, but to mixing or some other cause.

Unfortunately it is not possible to give a set of definite directions that would apply to every house-heating apparatus, telling how to supply the proper amount of air through the grate and over the fire. That is something

the attendant of the house-heating outfit must find out for himself. With some outfits burning a given coal under certain weather conditions, good results are obtained when the dampers in the ashpit door and the firing door are opened about the thickness of a match; in another outfit burning the same coal under similar conditions the dampers may have to be opened one-half inch; in still another apparatus best results may be obtained with both dampers closed, enough air finding its way in through the leaks. To give enough rules so that every case would be covered would make the rules so numerous that one would be at a loss which ones to use, and the rules would be worthless on account of their great number.

It should be borne in mind that when the dampers in the ashpit and the firing doors, as well as the doors themselves are closed, there is some air flowing into the apparatus, because it is impossible to make and maintain an absolutely air-tight fit of the dampers, doors and joints. The quantity of air that may leak into the apparatus when the doors and the door dampers are closed varies in different apparatus; it is larger in older apparatus than in a new one, thus introducing an uncertain factor in any set of rules.

There is, therefore, no one set of simple rules which when followed literally would insure economy in heating a house. Best economy can be obtained only after the attendant has become perfectly familiar with the furnace and its operation, and also the kind of fuel he is burning. He must have a good will to learn to run his apparatus and make an honest effort to get the best results that can possibly be obtained. He should not become discouraged if the amount of time he is giving to his furnace is entirely out of proportion to the saving of coal. After he has become perfectly familiar with all the faults and tricks of his furnace and his fuel, he will be able to get good results with comparatively little attention to the furnace. He must realize that it is distinctly up to him to get the best economy.

Some Useful General Suggestions

To burn the coal faster, supply more air through the grate. More air can be supplied by opening the damper in the pipe leading to the chimney, by opening the damper in the ashpit door, or by shaking the ashes down from the grate. Any one of these means or all of them may be used depending on how much faster one wishes to burn the fuel. To slow down the rate of combustion, reduce the draft by partly closing the chimney damper or close the damper in the ashpit door.

To increase the supply of air over the fuel bed, open the damper to the chimney or the damper in the firing door or both. Air introduced over the fuel bed helps in burning the gases and the visible smoke rising from the burning fuel. Too much air is as harmful to good economy as too little air.

As a general rule in house-heating furnaces, a heavy fuel bed gives more satisfactory results than light fuel beds, because, during the long periods between firing a light fuel bed is apt to burn down too much, making it difficult to build a new and effective bed. When burning bituminous coal it is better to place the fresh coal somewhat in a heap to one side of the grate and leave a small part of the burning fuel uncovered. This method of firing is found especially advantageous when the coal contains a large percentage of slack. When thus fired the coal is heated gradually and the volatile matter is distilled slowly and is given a chance to burn. Before the next firing, the coked heap of fuel should be broken and spread somewhat over the grate. A new charge is then placed on the opposite side of the furnace.

The frequency of shaking the ashes through the grate and the extent to which it should be shaken down depends entirely on how fast one wishes to burn the coal and must be determined by the attendant in each particular case. He should remember that it is the amount of air passing through the fuel bed that determines the rate of burning coal.

The fire should not be allowed to burn down too low before banking for the night, because it is liable to go out after banking. When banking the fire, a small part of the surface of the fuel bed should be left uncovered. This may avoid unpleasant explosion of the gases rising from the banked fuel.

The extent to which the dampers should be closed for banking the fire depends on the amount of air leaking into the ashpit, and must be determined by the attendant. It is safer to close the damper in the ashpit door and leave the damper leading to the chimney partly opened so that there is no danger of the coal gases finding their way into the house.

It is well to repeat that the foregoing are only general suggestions along which the attendant of the furnace should work. It is he who must determine exact rules in his special case to get the best results.

Saving Water and Conserving Coal*

By George W. Carpenter
City Engineer, Pawtucket, R. I.

Reducing to a reasonable figure water consumption in cities that have high per capita averages would save far more water than would a small horizontal cut in all cities. In the absence of any considerable volume of data throwing direct light on the question in hand, the author has used 1915 water consumption statistics of the United States Bureau of the Census as a basis for computing possible coal saving by reducing water consumption.

Statistics for 155 cities owning their works showed that for a total population of a little more than 25,000,000 an average of 3,748,000,000 gal. of water was supplied in 1915. The report states that 80 per cent. of the water supplied is pumped and that 80 per cent. of the pumping, or 64 per cent. of the total, is done by steam power—about 114 gal. per capita per day. The average horsepower of the pumps per million gallons capacity is given as 36.

Assuming a saving of 64 per cent. of 26,000,000 gal. daily (10 gal. per capita), an average of 36 hp. per 1,000,000 gal. pumped against a head of 207 ft., and a coal consumption of 2 lb. per hp.-hr., we find that 14⅜ tons of coal could be saved daily by a reduction of 1 gal. per day in the per capita consumption. This would be approximately 5200 tons of coal per year, or 52,000 tons if the per capita reduction were 10 gal. per day. Can water consumption throughout the country be reduced 10 gal. per capita per day? Yes, that amount and more, too, on the average.

Tackle the Heavy Water Wasters First

The writer, however, does not believe that this saving should be made by a uniform reduction of all consumption, regardless of present rates, for there are many cities that have already reduced water consumption to a very low figure, while others are wasting water in a prodigal manner.

An examination of the tabulated statistics of 148 of the cities reported, representing a total population of 25,644,000, indicates a daily per capita consumption varying from a minimum of 34 gal. for Woonsocket, R. I., to a maximum of 324 gal. for Buffalo, N. Y.

Of the 150 listed in the 1915 Census Report, 55, representing a total population of 4,590,000, now have an average per capita consumption of less than 100 gal. per day, and 88 cities, with a population of 14,546,000, have an average of 125 gal. or less per day. If we assume that 125 gal. per capita daily is a reasonable allowance, we find that 48 cities could save a total pumpage of 663,000,000 gal. daily, and that of this total Chicago alone could save 37 per cent. by reducing its present consumption of 226 gal. per capita per day to 125 gal. The four cities of Chicago, Philadelphia, Pittsburgh and Buffalo, with respective averages of 226, 182, 252 and 324 gal. per capita, could save 495,000,000 gal. per day, or nearly 75 per cent. of the total.

If we make the same assumption with respect to the 663,000,000 gal. that could be saved by the 48 cities referred to, namely, that 80 per cent. of the pumping is by steam power, we have a total of 530,000,000 gal. pumped by steam; and by applying our previous assumption as to the

*Abstract of paper presented at the Boston meeting of the New England Water-Works Association, September, 1918.

use of coal to pump this amount of water, we have a possible saving of 4558 tons of coal per day, or 32 times as much coal as could be saved if all cities reduced the per capita by 1 gal. per day. A saving of 458 tons daily is about 167,000 tons annually. Chicago, Philadelphia, Pittsburgh and Buffalo could save about three-fourths of this, or 125,000 tons, by a reduction of the average per capita water consumption to a figure already reached or improved upon by 88 of the 148 cities reported. If we assume a per capita allowance of only 100 gal. daily, a very much greater saving of coal can be made.

Pump Slip Should Be Reduced

The writer believes, however, that a reduction of consumption to reasonable limits is not the only objective which should be sought in order to conserve fuel. Pump slip is often a source of an enormous waste of power. We often find reports where total consumption, engine duty, etc., are figured to all manner of degrees of precision, only to discover, upon critical inspection, that all these figures are based upon plunger displacement, with no knowledge of, or attention paid to, the probable slip.

Referring to the figures previously used, 3,748,000,000 gal. pumped daily by 155 cities in this country, and calling 80 per cent. of this pumped by steam, we obtain 3,000,000,000 gal. If we assume a slip of 5 per cent. only, and use our previous figures of 36 hp. per million gallons and 2 lb. of coal per hp.-hr., we find that this slip is equivalent to the wasting of 130 tons of coal per day, or nearly 50,000 tons per year. This is about as much fuel as we found would be saved by reducing the average per capita consumption of the 155 cities previously cited by 10 gal. per day. If we stop to consider that in many pumping plants the reducible slip is probably greatly in excess of 5 per cent. we may realize that one profitable field of investigation may lie very close to the pumping station itself.

Unfair Burden on the Conscientious

To assume, however, that conservation of fuel can be obtained by a uniform reduction of the per capita consumption of water throughout the United States, without first giving wide publicity to the wastefulness existing in certain cities, is unfair to those cities and officials now using every effort to keep water consumption within reasonable and proper limits and conserve and increase pump efficiency. It will furnish one more example to the faithful, conscientious citizen hastening to do "his bit" and carrying also the additional burden caused by the thoughtless extravagance and wastefulness of those who will not or do not care.

Twenty-Four Billion Dollars

The Bankers Trust Co. of New York has prepared for use in connection with the Fourth Liberty Loan campaign, a pamphlet which is intended to set forth how America's contribution to the fourth year of the war against the Teutonic autocracy may be equitably shared by our 23,500,000 families.

The budgets of the Liberty Allies for the fifth year of the war call for the expenditure of around $50,000,000,000. Approximately half of this amount, or $24,000,000,000, must be provided by the United States. The problem for which this pamphlet endeavors to offer a solution is—how this great amount of money can be raised and how the burden shall be equitably prorated among the 23,500,000 families of our country.

Taking as a starting point the data upon which the revenue bill that has just passed the House of Representatives by unanimous vote was based, it is estimated that the corporations other than banks will provide $6,000,000,000; the banks about $5,500,000,000; while $3,000,000,000 to $3,500,000,000 it is estimated will come from indirect taxation; leaving over $9,000,000,000 which must be provided from individual incomes. The revenue bill places a heavy burden of taxes upon the corporations—an amount aggregating something over $4,000,000,000—it also places the weight of the personal-income tax on those receiving the larger incomes. Necessarily, therefore, the burden of the bond-buying must be borne by individuals receiving the smaller incomes.

A striking fact developed in this pamphlet is that of the 23,500,000 family groups into which our 106,000,000 population naturally falls, 23,140,000 having incomes of $5000 or less receive 76 per cent. of the national income which is conservatively estimated to be sixty billion dollars and 21,175,000 of these families—receiving incomes of $2000 or less—are credited with receiving over two-thirds of the entire national income.

In conclusion, attention is called to the fact that the very destinies of the nation—perhaps of the world—depend upon the loyal response of each one of us to the call for subscriptions to the Liberty Loans. While the banks and corporations must do their full share, and also the families and the individuals of wealth and of great wealth, for the great sum of $6,000,000,000—fully one-fourth of the entire $24,000,000,000 required—the Government will be dependent upon the recipients of incomes of $10,000 or less; and for over one-fifth of the amount required—for nearly $5,000,000,000—it must look to the members of the families receiving incomes of $2000 and under.

The pamphlet is accompanied by a table which gives the estimated contribution for each family group from those receiving incomes of $1000 up to those receiving incomes of $5,000,000 and over.

The most important items are retabulated here.

FINANCING THE WAR

For the Fiscal Year Ending June 30, 1919

Family Income Group	Average Percentage Contributable by Each Family in Group	Average Amount Contributable by Each Family in Group
$1,000— $2,000	11.00	$209
2,001— 3,000	18.50	518
3,001— 4,000	24.50	931
4,001— 5,000	28.00	1,316
5,001— 6,000	31.50	1,795
6,001— 7,000	33.60	2,184
7,001— 8,000	36.00	2,700
8,001— 9,000	38.00	3,230
9,001— 10,000	40.00	3,800
10,001— 15,000	43.60	5,460
15,001— 20,000	47.75	8,356
20,001— 25,000	50.50	11,363
25,001— 30,000	52.75	14,506
30,001— 40,000	55.50	19,425
40,001— 50,000	58.00	26,100
50,001— 60,000	59.75	32,862
60,001— 70,000	61.25	39,812
70,001— 80,000	62.50	46,875
80,001— 90,000	63.50	53,973
90,001— 100,000	64.50	61,275
100,001— 150,000	66.50	81,795
150,001— 200,000	69.25	120,495
200,001— 250,000	79.80	159,300
250,001— 300,000	72.20	199,994
300,001— 400,000	73.60	253,920
400,001— 500,000	75.30	337,344
500,001—1,000,000	77.80	531,374
1,000,001—1,500,000	80.40	889,224
1,500,001—2,000,000	82.50	1,403,325
2,000,001—3,000,000	84.20	2,070,478
3,000,001—4,000,000	85.75	2,966,092
4,000,001—5,000,000	86.75	3,915,895
5,000,001—and over	90.00	9,255,000

To use the table find your family income in Column I. Multiply by the percentage in Column II. Deduct your income tax liability. The balance will be the quota of bonds to be bought during the year. Take one-third of the amount this time. For example:

Income, $5,000. Multiply by 28 per cent	$1,400
Deduct income tax (new bill)	180
Balance for bonds, one year	$1,220
Fourth Loan—one-third, say	400

The pamphlet is issued for free distribution as an aid to men and women who desire to contribute systematically to the success of the war financing.

[The foregoing table if adhered to would bring success only if each family in the group contributed to the amount of bonds in proportion to their respective incomes. As thousands of families will not purchase bonds at all and others will not take their proper allotment, it will be necessary for those that do purchase their proportionate number of bonds to buy in excess of their average as given in the table if the present issue is to be successful.—Editor.]

To waste in these times is to fight on the side of the Kaiser. To save continuously is doing our duty. Think before you spend. Do not spend foolishly. "Save and serve. Remember waste means want somewhere." Be a 100-percent. American; now!—*Publicity Magazine.*

Emergency Power Act Passes House

The Emergency Power Bill introduced by Representative Sims on Aug. 19, 1918, passed the House on Oct. 1. By its terms the President is authorized and empowered, within the limits of the appropriation of $175,000,000, "to construct at any place or places within the boundaries of the United States such power plant or power plants as he may deem necessary, and in connection therewith to construct within such boundaries plants for the production of gas, coke, toluol, benzol, coal-tar products and any other useful products that may be produced through or in connection with the coking of coal or lignite, or through or in connection with the combustion of any fuel."

He may also install in any private power plant any appliances or machinery that he may deem necessary to increase the capacity or productivity of such plant, or may provide the operator of the plant with funds to do so. He may lease the machinery or appliances thus installed to the operator for the war period or for such period thereafter not exceeding five years, or for any shorter period, on such terms as he may deem reasonable. Such machinery or appliances remain the property of the United States until they are sold or otherwise disposed of and are not subject to lien, mortgage, judgment or other encumbrance. In default of any payments due the United States under lease or contract, the President may enter upon the premises and maintain and operate such appliances or machinery free of rent or other charge, or take possession of them and remove any or all of them.

He is further empowered to equip or expand any private power plant by advancing money to the operator, but he must agree with the operator that, if the reasonable cost of thus equipping or expanding the plant is in excess of the value of the plant at the end of the war period, or at such later time not more than five years after the end of the war period, and if the machinery and appliances constituting the added equipment shall have been operated and maintained in accordance with his directions until that time, repayment of the whole or any part of such excess will be waived, and provide by agreement for the manner of determining such costs or values and for the terms and time of repayment. But these powers shall be exercised only if the President deems it impracticable or undesirable to act with respect to such plant under any of the other powers of the Act.

The President may acquire—that is, purchase, requisition, condemn, lease, etc.—any private power plant in the United States. He may construct pipe or transmission lines or other structures to increase the facilities of a plant or to combine the facilities of two or more such plants and may maintain, operate or extend any such line, structure or facility, and deliver the power generated or the products made to such persons and at such rates as he may deem proper.

By the terms of the Act he may requisition or acquire, during the war period, the whole or any part of the power generated by such a power plant and may distribute it or cause it to be distributed as he may direct. He may lease for the war period or for any period thereafter not exceeding five years, on such terms as he may deem reasonable, any plant, line or other property acquired under the terms of the Act. He may modify, cancel or suspend any existing or future contracts for delivery of power to persons not engaged in producing war material; and he may acquire any property that he may deem necessary for the construction, expansion or operation of plants or transmission lines.

He is empowered to form corporations to purchase, build or lease power plants; he may sell or exchange any plants taken by him and any property to which he has taken title, whenever the interests of the country, in his opinion, warrant such action. But whenever appliances installed by him in a private plant or in a plant to which he has taken title constitute an integral part of the plant, so that it would be uneconomical to separate them therefrom, the owner of the plant shall have the option of buying them at their then reasonable value, to be determined by agreement or arbitration.

In the matter of paying for plants and property acquired the Act provides that just compensation shall be made in an amount and in the manner prescribed by the President. If the person entitled to receive it is dissatisfied, 75 per cent. of the amount determined by the President shall be paid and such person shall be entitled to sue the United States for the amount which, added to the 75 per cent., will make up a just compensation.

No structure affecting the navigable waters of the United States may be constructed or installed under this Act until the plans therefor have been approved by the Chief of Engineers and the Secretary of War, or such other body as Congress may designate.

If any person knowingly neglects or refuses to comply with any order or requisition of the President or his authorized agent, or if any person attempts to obstruct the enforcement of such order or requisition, or if any person by means of fraudulent statements induces or tries to induce the President or his authorized agent to lend, advance or provide money, install property, or enter into contract according to the provisions of the Act, such person shall be punished by a fine of $5000 or by imprisonment for not more than two years, or by both.

The Act carries an appropriation of $150,000 to cover the administrative expenses incurred, and for the purpose of construction, acquisition, maintenance and operation of plants, transmission lines and other property according to the provisions of the Act the sum of $175,000,000 is appropriated, to be available during the time the Act is in effect. This latter amount is a reduction from the $200,000,000 stated in the original and unamended bill.

In case of the sale of any plant or property constructed or acquired under the Act, or the lease or operation of such plant or transmission line, all revenue derived shall be deposited in the Treasury to the credit of the appropriation.

Electrical Engineers for Signal Corps

At present there is a shortage of officer candidates having the required technical and personal qualifications available for Signal Corps Officer Training Schools. It is desired to secure by voluntary induction, for assignment to an Officers' Training School during the next two months, the services of a considerable number of electrical engineers who are available for full military duty, and who are between the ages of 20 years and 9 months and 45 years.

In view of the technical nature of the duties of signal officers, the most suitable candidates for commission as such are electrical and radio engineers who have had experience in power or communication work. Such men have a good knowledge of electrical matters, including the fundamentals of alternating and direct currents and have little difficulty in picking up rapidly the principles involved in the construction and operation of telephone, telegraph and radio systems. Graduates of four-year courses in electrical engineering and who have had one or two years of electrical experience, or practicing electrical engineers who have had five or six more years' experience and who have a knowledge of how to handle men are regarded as ideal candidates for commission in the Signal Corps. Such men will find that they are using their previous training and education for their own best interests and for the best interests of the service.

It is desired by the Signal Corps to receive applications for service from men who are qualified as outlined in the preceding paragraph. Such men will be individually inducted into the Army and assigned as enlisted men to an Officer Candidates' Training School, which is now being maintained by the Signal Corps. This plan of entering the service as enlisted men is now universally followed in the Army. Such men will be assigned to a course of technical instruction for officer candidates lasting thirteen weeks, during which time they will receive such instruction and review as is needed to qualify them technically. At the completion of this period, those who have shown by their record that they are officer material will either be commissioned in the grade of second lieutenant at once or assigned to a course of further military instruction as officer candidates at a Signal Corps camp. Opportunities for further

promotion are excellent, especially for men of balance and judgment, who have had sufficient experience to be capable of taking responsibility. Those who do not qualify as officer candidates will remain in the Army in an enlisted grade and will be assigned to an organization of the Signal Corps and given opportunity to develop the qualities in which they are lacking.

Electrical and radio engineers who desire active service ir the Army with opportunity to secure commission should fill out application for service blank, which may be secured from the Office of the Chief Signal Officer, Training Section, setting forth completely their military status, together with their experience and training. On being accepted for service, they will be inducted into the Army in the grade of private and sent to an Officers' Training School with such prospects as have been herein outlined.

Electric Thawing of Frozen Water Pipe*

By Frank J. Gifford

Thawing frozen water mains by electric current was the method commonly employed, according to reports from a considerable number of works obtained by the Committee on Frozen Water Pipes, of which the writer was chairman. Current from lighting wires, portable motor-generator sets and storage batteries was used.

The method best known and most generally used was connecting with the overhead wires of the lighting companies. In this type the high-tension primary wires, carrying 2200 to 2400 volts, were tapped, and the current was carried to cutout boxes with suitable fuse wires. From the fuse boxes the wire ran to one or more transformers whose capacities ranged from 15 to 75 kw. In a large majority of cases the voltage was reduced by the transformers to 110, and the amount of current delivered upon the pipe was further controlled by the use of a water rheostat.

Motor Generators on Trucks

The motor-generator set was used to a considerable extent. One outfit consisted of a 25-volt 250-ampere direct-current generator, equipped with a voltmeter, an ammeter and an automatic circuit-breaker, mounted on a motor truck. On the truck was also mounted a countershaft carrying a sprocket wheel at each end, and a driving pulley was connected to the generator by means of a leather belt. On each side of the jackshaft of the truck was attached a new sprocket wheel just outside of the existing driving sprockets. Upon arrival at the point where the work was to be done, the chains were taken off the driving sprockets and attached to the new sprockets at the jackshaft and to those on the counter shaft mounted on the truck. The motor-truck engine was thus utilized to generate the required current.

A limited use was made of the storage battery. One outfit consisted of three trays, each containing eight 2-volt cells, so connected up that a voltage of 16, 32 or 48 could be obtained. Another of six trays of four 2-volt cells was still more flexible, as voltages of 8, 16, 24, 30, 36 and 42 were possible. Another of six trays of three 2-volt cells was connected in multiple series, giving a voltage of 35. This outfit proved unsatisfactory, as serious damage was done to the pipes in a number of cases.

The properly connected storage battery has proved very portable, and when operated by an experienced man the method is safe. If it is improperly used, damage to the pipes and to the battery itself can result easily. The batteries must be recharged after a continuous day's use, the operation taking eight hours. The storage battery is delicately constructed and can be easily damaged both in discharging and in recharging. It deteriorates when not in use, especially during the long period of the year when it is not needed.

While available data are to some extent conflicting, and more exact information is desirable, general experience shows that for the work of thawing ⅝-in. lead or ¾-in. iron service pipes of average length, using 4/0 wire for leads, and with good connections, the following figures may be considered as approximately normal: Drop in pipe, 14 to 18 volts; total voltage required, 20 to 30; amperes required, 175 to 225; time required to thaw, 6 minutes, plus or minus. With larger pipes, or with pipes longer than the average, of course more electrical energy and time are required.

For all-round, efficient, economical work the committee looks most favorably upon the motor-generator set. It is flexible, can be taken where the work is to be done, can work continuously, does not deteriorate when not in use, can be made almost foolproof and, if properly designed, is the safest type of apparatus from the point of view of avoidance of danger to the water pipes.

Never in the history of the world has the absolute dependence of one nation upon another, one community upon another and one individual upon another been recognized as it is today. This world war has brought home to thinking minds a realization of individual responsibility, of the necessity of unity of purpose, and of individual sacrifice for the common good, that could have been produced in no other way.

Today, therefore, is an opportune time to bring to the attention of those cities whose prodigal use of water amounts almost to a crime the fact that such wastefulness is far-reaching, that its effect extends beyond the borders of the city itself and may reach even across the seas, tending to withhold from those brave men upon whom civilization is now depending for its very existence the arms, ammunition and supplies needed in its defense.

*Abstract of Committee Report at the New England Water Works Convention, Sept. 11-12, 1918.

New York Has Official Ice Breaker

Frederick D. Underwood, president of the Erie Railroad, is official ice-breaker of the Port of New York. In making this appointment the War Department has coöperated with the United States Fuel Administration and the New York State Fuel Administration to clear the way for coal should the bay and river become icebound. The War Department has sole jurisdiction over navigable waters.

Mr. Underwood is a veteran ice-breaker. When in charge of the "Soo" Lines, he devoted most of his time in winter to keeping the Straits of Mackinac open for car ferries and other vessels, and he knows how to handle heavier ice than New York ever saw. Hereafter he will be in charge of harbor operations in New York and New Jersey waters as affected by ice conditions. The Federal Government, through the Shipping Control Committee, will furnish vessels suitable for breaking ice under Mr. Underwood's direction.

Rules For Hot-Water Heating Systems

Mercer P. Moseley, Chief of Conservation for New York State, says that hot-water heating plants should save coal, but do not when the following directions are not followed:

All the water should be emptied from the plant and clean water put in at least as often as every spring and every autumn.

When the first fire of the season is built, as the water gets heated, take the radiator key and open up the exhaust-valve of each radiator in turn until all the air remaining in each radiator is allowed to escape. Repeat this operation occasionally to make sure there is no air interfering with free circulation of the water.

Always be sure that water shows in the glass gage of the exhaust tank, which is usually located in the top story of the house above the level of all radiators.

Be sure the boiler is covered with asbestos, as well as the pipes in the cellar.

A Swedish engineer had a neat way of making a loose stud hold. With a hacksaw he cut two slots at right angles across the stem end of the stud the full length of the threaded part, and, after countersinking the end, he dropped a steel ball into the tapped hole of the stud, and screwed the split stud down onto it, which, of course, expanded the end.—*Int. Marine Engineering*, N. Y.

New Publications

SAVING COAL IN BOILER PLANTS

Technical paper 205, Bureau of Mines, by Henry Kreisinger. In a 24-page leaflet Mr. Kreisinger tells in a brief but forceful way of the chief things that must be done in a power plant to save coal. This leaflet may be had free by addressing the Director of the Bureau of Mines, Washington, D. C.

WEIGHTS OF VARIOUS COALS

The Bureau of Mines has just issued technical paper 184, by S. B. Flagg, devoted to the weights of various American coals. The following is from the conclusions of the author:

"A study of the coals indicates that the heavier weights may be expected for coals of high fixed carbon content than for those of low fixed carbon content. Increased ash content seems to lower the unit weight. It is also true in general that the coals high in moisture are lighter than those low in moisture, and the younger coals are lighter than the older coals. These variables combine in so many ways, however, that it is difficult to determine from the data available anything more than a general change and consequently little use can be made of the knowledge of the change of one or more of the variables. The weights per cubic foot, for the same coals when wet, or when stored in a deep pile or bin, or in a car which has been jarred and bumped in transit, may be quite different.

"For this reason one should not expect that the use of the weights per cubic foot contained in the table will give accurate results say within 10 to 15 per cent., if applied to coal in storage pile, or other place where the material is liable to be in a compact mass.

"In glancing over the table one finds that the coals vary from 43 to 58 lb. per cu.ft."

Obituary

Mrs. Ella Gertrude Eno, who was the only licensed female engineer in Massachusetts, as reported in the issue of Sept. 17, died at her home in Lynn, Mass., on Oct. 8, of influenza. Mrs. Eno and her husband conducted a wet-wash laundry in Lynn, and upon their failing to get an engineer after advertising for one for four weeks, Mrs. Eno, who had been receiving tuition from her husband, a licensed engineer, took the required engineer's examination and passed it. She was 31 years old, and is survived by her husband, a son, three brothers and two sisters.

Personals

Frank A. Morrison has been appointed secretary of the Mason Regulator Co., Boston, Mass., after a service of 25 years with the company.

Edgar P. Kable has been elected general manager of the York Water Co., York, Penn., succeeding W. H. C. Ramsey, who resigned about a year ago.

C. E. Persons, of San Francisco, has been appointed Director of Education of the Fuel Administration. Mr. Persons has been connected with the Western Division of the Associated Press for seven years and for the last three years has been news editor of that division. At the request of Dr. Garfield, the Associated Press has released Mr. Persons for this work.

Robert C. Byler, for four years advertising production man for the S K F Ball Bearing Co., of Hartford, Conn., has been appointed advertising manager of the S K F Administrative Co., of New York City, and will direct the advertising of the S K F Ball Bearing Co., of Hartford, the Hess-Bright Manufacturing Co., of Philadelphia, and the Atlas Ball Co., of the same city, all of which are controlled by the S K F Administrative Co. Until arrangements are made in New York City Mr. Byler will remain with the S K F Ball Bearing Co., of Hartford, Conn.

Engineering Affairs

The Philadelphia Section of the A. S. M. E. will hold a meeting on Oct. 22.

The Providence Section of the A. S. M. E. will hold meetings on Oct. 15, 22 and 29.

The American Society of Mechanical Engineers has established a section in Cleveland known as the Mechanical Section of the Cleveland Engineering Society. This new section comprises over twenty bordering towns or cities. It is hoped that papers presented at the proposed joint meetings in Cleveland may be published simultaneously in the "Journal of the Cleveland Engineering Society" and the "A. S. M. E. Journal."

The Council of the American Society of Mechanical Engineers will meet in Indianapolis, Ind., Oct. 25 and 26, and in connection with this meeting an elaborate gathering of the Indianapolis, Cincinnati, St. Louis, Chicago, Milwaukee, Detroit and Cleveland sections has been arranged. The Indiana Engineering Society, The Indianapolis-Lafayette section of the American Institute of Electrical Engineers and the Indianapolis section of the American Society of Automotive Engineers have also been invited. Headquarters will be the Claypool Hotel, where two professional sessions and the committee meetings will be held. On Friday afternoon, Oct. 25, there will be a symposium on Fuel Conservation: An explanation of the regulations of the Fuel Administration, by Dr. P. B. Noyes, Director of Coal Conservation, United States Fuel Administration; What the Fuel Administration expects of the engineers, by David Moffat Myers, Advisory Engineer, United States Fuel Administration; and discussion in which the administrative engineers of the Fuel Administration and members of the society will participate. In the evening there will be an informal dinner at which the nominee for president, M. E. Cooley, is expected to speak, followed by war pictures. On Saturday morning, Oct. 26, there will be a symposium on Research, with opening address by Prof. Walter Rautenstrauch, member of the society's Committee on Research, and an address by Dr. W. J. Lester, vice chairman of the Mechanical Engineering Division of the National Research Council, followed by discussion by members of the society, and an exhibition of the Liberty Motor. The committee is arranging many interesting visits in the afternoon.

Miscellaneous News

The Boiler of a Freight Locomotive Exploded on the Front Street grade crossing of the Reading Railway at Lebanon, Penn., on Oct. 1, instantly killing two men and seriously injuring three others, one so badly that he is not expected to recover. The five men composed the crew of the freight train and were all riding in the cabin when the boiler let go with a terrific force that shook the eastern end of the city and the buildings of the local plant of the Bethlehem Steel Co. The crown-sheet was blown completely off, and the bodies of two of the men were blown 300 ft. in opposite directions. The cause of the explosion is unknown.

The West Chicago Park Commissioners are contemplating a combination of their present electrical division and steam heating division into a mechanical and electrical division. If this change is made a mechanical and electrical engineer will be placed at the head of the new division. This announcement is being made in order to get in touch with persons interested in this new position, which will pay about $3300 per year at the start and $3600 per year as soon as the incumbent has fully demonstrated his ability to satisfactorily handle the work. The entire service of the Park Commissioners is operating under a stringent civil-service law which insures permanent tenure to all efficient and competent employees. The final appointment to this new position will be given to the person who receives the highest average in a civil-service examination open to men residing anywhere in the United States.

Trade Catalogs

The Defender Automatic Regulator Co., Oriel Building, St. Louis, Mo., has issued catalog No. 10. This is a loose-leaf publication containing 56 pages and illustrates the company's line of draft gages, CO_2 apparatus, thermometers, pyrometers, pressure gages, damper regulators, reducing valves and other boiler-room efficiency instruments and appliances.

New Construction

PROPOSED WORK

R. I., Providence—The Rhode Island Malleable Iron Works, Hillsgrove, plans to erect a 2-story, brick and concrete pattern storage house. Plans include the installation of a steam heating system. Total estimated cost, $100,000.

Conn., Groton—The Harry Zavoritis Development Co., 8 State St., plans to build a 4-story, 120 x 126 ft. hotel. Plans include the construction of a boiler room and cold storage plant. Total estimated cost, $400,000. L. E. Conway, Goldsmith, Bldg., New London, Arch.

N. Y., New York—F. L. Dowling, Pres. of Manhattan Borough, will soon receive bids for installing extra set of 2300 volt bus bars and replacing existing set; also installing additional panels, switches, buses, etc., and changing gallery of substation on Blackwells Island. Former bids rejected. Estimated cost, $10,000. N. B. Lewis, Municipal Bldg., Engr.

D. C., Wash.—The Potomac Electric Power Co. plans to issue $2,100,000 bonds for extensions and improvements to its power plant; plans include the installation of a new 15,000-kw. turbo generator with auxiliary equipment. G. H. Rettew, Ch. Engr.

N. C., Tarboro—The City Council approved a bond issue of $50,000 for extensions and improvements to the power plant. J. H. Jacobs, City Clk.

Tenn., Johnson City—The Lansing Mining Co. is in the market for a 20 to 25 h.p. gas or oil engine, also a new or second-hand air compressor.

Tenn., Memphis—The Memphis Furniture Co., 715 South Camilla St., is in the market for a new or second-hand 250-hp. Heine water tube boiler.

Ky., Louisville—A. L. Noe, 1414 Starks Bldg., is in the market for one or more 150 h.p. or smaller horizontal tubular boilers.

Ind., Corydon—Curtis Bros. is in the market for one to three new or second-hand horizontal tubular boilers.

Ohio, Alliance—The Fraternal Order of Eagles will install a steam-heating system in the proposed 4-story, 40 x 110 ft. store and clubhouse which it plans to build on Main St. Total estimated cost, $100,000. W. W. Matchett, Main St., Engr.

Ohio, Cleveland—The Brown Hoisting Machine Co., East 45th St. and Clair Ave., plans to erect a 2-story, 120 x 140 ft. factory. Plans include the installation of a steam heating system. Total estimated cost, $100,000. E. M. McGeorge, 1900 Euclid Bldg., Arch.

Wis., Biron (Grand Rapids P. O.)—The Consolidated Water, Power & Paper Co., Grand Rapids, plans to build a 2-story addition to its hydro-electric plant and paper mill here. Estimated cost, $75,000. L. A. DeGuere, Con. Engr., preparing plans.

Wis., Oconto—The Oconto Service Co. has had plans prepared for improvements to its power plant to include the installation of water turbine generator, switchboard, etc. Mead P. Seastone, State St., Madison, Engr.

Iowa, Truro—The Truro Light & Power Co. is in the market for 15kw. and 25kw., 3-phase, 60-cycle, 2300 volt generators.

Kansas, Baxter Springs—City will improve waterworks consisting of construction of pumping station and installation of pumps, engine, boiler, belts and pipe. W. P. Howard, City Clk.

Neb., Clarkson—City voted $26,000 bonds for installation of power plant, also equipment, including engines, boilers, switchboard, heater and deep-well pump. Henningson Engineering Co., 1122 Farnham St., Omaha, Engr.

Ark., Wynne—The city plans to improve its electric light plant, including the installation of new machinery. Estimated cost, $25,000.

Ariz., Phoenix—City plans election Oct. 23 to vote on bond issue of $100,000 for constructing pumping plants in connection with drainage project of Salt River Valley water users.

Ont., Toronto—Norman Taber, 444 Bathurst Co., is in the market for a 50 h.p. high speed automatic governor.

Ont., Toronto—The Turnbull Elevator Manufacturing Co., 126 John St., will build an addition to its boiler plant. Estimated cost, $6000.

Ont., Windsor—The Canadian Salt Co., Sandwich St., plans to build a 1-story boiler house. Estimated cost, $5000. E. G. Henderson, Supt.

Man., Winnipeg—William Kragh plans to build a 1-story power house and a 3-story factory. Total estimated cost, $60,000.

James Chisholm & Sons, 807 West Permanent Bldg., Arch.

CONTRACTS AWARDED

Mass., Chicopee—The United States Government received low bids for the construction of an engine room at Hill Shop of the Westinghouse Electric Co. of New England from Casper Ranger Construction Co., Holyoke, $34,705; Ernest F. Carlson Co., 310 Main St., Springfield, $34,889; Adams & Ruxton Construction Co., 33 Lyman St., Springfield, $37,000; Flynt Building & Construction Co., 356 Main St., Palmer, $38,461; Fred T. Ley Co., 495 Main St., Springfield, $40,000.

R. I., Providence—The New England Supply Co., Gordon Ave., has awarded the contract for the erection of two factory buildings, one 62 x 190 ft. and other 15 x 44 ft.; also a 31 x 65 ft. boiler house on Elmwood Ave. to Herbert Mathewson, 97 Peace St.

Ill., Chicago—Bids were received Sept. 26 by Sanitary District for furnishing equipment for Evanston sewage pumping station (a) three 14 in. and three 30 in. centrifugal pumps, (b) one 30 in. centrifugal pump, (c) two 14 in. centrifugal pumps, (d) one 30 in. centrifugal pump, (e) two 14 in. centrifugal pumps, (f) six vertical induction motors with transformers, etc., (g) control switchboard and wiring from Nash-Dowdle Co., 29 South LaSalle St., (a) $150,000, (b) $22,000, (c) $16,200, (d) $23,000, (e) $17,000, (f) $98,500, (g) $27,000; T. J. Forschner Contracting Co., West 127th St. and Port Huron & Southern Ry. tracks, (a) $185,000, (b) $35,000, (c) $20,000, (d) $32,000, (e) $22,000, (f) $100,000, (g) $29,000; A. S. Schulman, 417 South Dearborn St., (f) $24,734, (g) $12,296; Freeman Sweet Co., 60th and South Dearborn St., (f) $30,180, (g) $30,028; Henry Newgard Co., 947 Washington Bldg., (g) $11,890.

N. J., Trenton—The city has awarded the contract for the installation of one 25,000,000 gal. steam driven and one 20,000,000 gal. electrically driven centrifugal pumps, 1 motor, 1 generator, with appurtenances, etc., to Barry E. Stahl, 275 Bellevue Ave. Estimated cost, $123,000. Noted Sept. 5.

Fla., Jacksonville—The city has awarded the contract for furnishing transformers for 12 months from Sept. 1, to the Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C.; electric meters for 12 months from Sept. 19, to the Florida Electric Supply Co., Union Terminal Bldg. Cost will depend on city requirements for a year. Noted Sept. 3.

Ohio, Akron—G. P. Hoffman, Dir. of Pub. Ser., has awarded the contract for furnishing one 30 in. and one 36 in. motor driven gate valve, 450 hand operated gate valves from 3 in. to 42 in. in size and three 10 in. automatic air valves, to the Rensselaer Valve Co., Ontario St., Troy, N. Y. Estimated cost, $47,279. Noted Sept. 3.

Ohio, Cleveland—The Board of Education, Rockwell Ave. and East 6th St., has awarded the contract for the installation of a steam heating system in the 1-story, 75 x 125 ft. gymnasium which it plans to build on Franklin Ave., to the Becker-Seidel Co., 324 Prospect Ave. Total estimated cost, $150,000.

Ohio, Cleveland—The Board of Education, Rockwell Ave. and East 6th St., has awarded the contract for the installation of a steam heating system in the 1-story, 75 x 125 ft. gymnasium which it plans to build on Scranton Road, to the Chapell Warren Co., 1384 East 6th St. Total estimated cost, $150,000.

Minn., Minneapolis—The Pillsbury Flour Mill Co., Metropolitan Life Bldg., has awarded the contract for the erection of a 3-story power plant for its flour mill on 3rd Ave., S. E., and Main St., to Siems, Helmers, Schaffner, 514 Guardian Life Bldg., St. Paul.

Okla., Guthrie—The Feifer School has awarded the contract for the installation of a heating plant, to Benson & Farrar. Estimated cost, $20,000.

Cal., San Diego—Bids were received at San Diego Navy Yard for constructing seven permanent buildings at Naval Air School on North Island, including a dirigible store house, hydrogen generating plant, hydrogen storehouse, laboratory, compressor building, oil storage and reclaimer building, two blower houses and a pump house, from Los Angeles Planing Mill Co., 1812 Industrial St., Los Angeles, $58,391; J. D. Kneen Construction Co., Santa Monica, $60,961; Henry Clark Co., 1101 East 5th St., Los Angeles, $61,888.

N. F., St. Johns—The Reid-Newfoundland Co. will build a large cold storage plant to have a capacity of 12,000,000 lb. of fish which will be enlarged later to a capacity of 50,000,000 tons.

WASHINGTON, D. C.

The Bureau of Supplies & Accounts, Navy Department, will soon receive bids for furnishing equipment as follows:

Schedule No. 6329½, one automatic power hammer, delivery, Wash., D. C.

Schedule No. 6368½, one air compressor, delivery Wash., D. C.

Schedule No. 6370½, seven steam towing machines and spares, delivery Puget Sound, Wash.

Schedule No. 6163½, six 5 h.p. motors and one coal crusher, delivery Wash., D. C.

Schedule No. 6230½, one electrically-operated grab bucket, delivery Wash., D. C.

Schedule No. 6263½, one motor driven metal saw, delivery Key West, Fla.

The Bureau of Supplies & Accounts, Navy Department, will receive bids for furnishing equipment as follows:

Oct. 15, Schedule No. 6380½, one 5 h.p. motor, delivery Norfolk, Va.

Oct. 18, Schedule No. 6410½, motor equipment, delivery Philadelphia, Pa.

Bids were received by the Bureau of Supplies & Accounts, Navy Dept., for furnishing equipment as follows:

Schedule 5972½, Class 857, induction motors, delivery Wash., D. C., from Crocker-Wheeler Co., Ampere, N. J., $3022; Howell Electric Motors Co., Bourse Bldg., Philadelphia, Pa., $2050; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $653 (part bid); North Western Manufacturing Co., 480 Clinton St., Milwaukee, Wis., $2069 (part bid); Robbins-Meyers Co., Lagonda Ave. and Farlow St., Springfield, Ohio, $308; Triumph Electric Co., Liberty Bldg., Philadelphia, Pa., $1176, alternate, $1149; Triumph Electric Co., South St., Cincinnati, Ohio, $976; Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $2244; Fairbanks Morse Co., 101 Light St., Baltimore, Md., $1562, (part bid); General Electric Co., River Rd., Schenectady, N. Y., $2008; Ideal Electric Co., 153 East 5th St., Mansfield, Ohio, $1170, (part bid).

Schedule 5995½, Class 871, motor generating set, delivery White Plains, Md., from Allis-Chalmers Manufacturing Co., Clinton St., Milwaukee, Wis., $22,740; Westinghouse Manufacturing & Electric Co., Hibbs Bldg., Wash., D. C., $21,980; General Electric Co., River Rd., Schenectady, N. Y., $23,105.

Schedule 5997½, Class 876, motors, delivery White Plains, Md., from Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $8200; Allis-Chalmers Manufacturing Co., Clinton St., Milwaukee, Wis., $6512.

Class 877, 350 h.p. motor, delivery White Plains, Md., from Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $2820; Allis-Chalmers Co., Clinton St., Milwaukee, Wis., $4107.

Class 878, 200 h.p. motor, delivery White Plains, Md., from Triumph Electric Co., South St., Cincinnati, Ohio, $2848; Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $2409; Allis-Chalmers Co., Clinton St., Milwaukee, Wis., $2763; Ideal Electric Co., 153 East 5th St., Mansfield, Ohio, $2725.

Class 879, 10 h.p. motor, delivery White Plains, Md., from Crocker-Wheeler Co., Ampere, N. J., $518; Lincoln Electric Co., Real Estate Trust Bldg., Philadelphia, Pa., $388; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $421; Northwestern Manufacturing Co., 480 Clinton St., Milwaukee, Wis., $301; Triumph Electric Co., South St., Cincinnati, Ohio, $404; Westinghouse Electric & Manufacturing Co., Hibbs Bldg., Wash., D. C., $393; Allis-Chalmers Manufacturing Co., Clinton St., Milwaukee, Wis., $422; Ideal Electric Co., 153 East 5th St., Mansfield, Ohio, $465.

Schedule 6001½, Class 935, turbo-generator units, delivery Wash., D. C., from De Laval Steam Turbine Co., Clinton St., Trenton, N. J., $16,694; General Electric Co., River Rd., Schenectady, N. Y., $10,250; Kerr Turbine Co., 30 Church St., New York City, N. Y., $9792; Moore Steam Turbine Corporation, Real Estate Trust Bldg., Philadelphia, Pa., $8155.

The Bureau of Supplies & Accounts, Navy Department, has awarded the contract for furnishing equipment as follows:

Schedule No. 5645½, air compressors, to Ingersoll Rand Co., 11 Broadway, New York City, N. Y., $9161.

Schedule No. 5777½, Class 614, air compressors, to Ingersoll Rand Co., 11 Broadway, New York City, N. Y., $62,673.

Schedule No. 5763½, Class 586, motor generating set, delivery San Diego, Cal., to Fairbanks Morse Co., 101 Light St., Baltimore, Md., $1177. Noted Oct. 1.

Schedule No. 5746½, Class 546, electric hoists, delivery Boston, Mass., to Detroit Hoist & Machine Co., Clay St., Detroit, Mich., $2250. Noted Oct. 1.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck.	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.30

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70	$3.25—3.40	
Mine-run	2.35—2.50	3.00—3.15	
Screenings	2.05—2.20	2.75—2.90	

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene			

St. Louis—Prices per net ton bituminous coal f.o.b. mine today as compared with a year ago are as follows:

	Williamson and Franklin Counties, Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.55@2.75	$2.40@2.70
Mine-run	2.35@2.50	2.20@2.30
Screenings	2.17@2.32	1.50@1.50

Williamson-Franklin rate to St. Louis is $1.10.

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